INSTRUCTION MANUAL
MODEL 651XP

California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

California Instruments Corporation

9025 Balboa Avenue, San Diego, CA 92123-1509

(619) 279-8620 (800) 4-AC-POWER
FAX (619) 279-8139

California INSTRUMENTS

Revision D
July 1988

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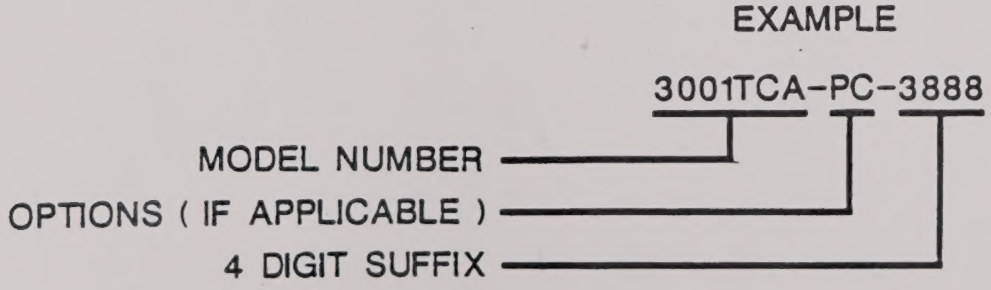
P/N 4000-961

INSTRUCTION MANUAL
MODEL 651XP

Invertron®

NOTE:

ASSEMBLIES, SCHEMATICS AND PARTS LISTS MAY DIFFER FROM THIS MANUAL IF MODEL NUMBER HAS A 3 OR 4 DIGIT SUFFIX. SEE SERIAL NUMBER TAG FOR PROPER IDENTIFICATION.



XP SERIES MANUAL

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651XP
LIST OF DRAWINGS

ASSEMBLY REFERENCE DESIGNATORS	DRAWING NUMBER	TITLE
	4000-901	Outline Drawing
	4000-411	Top Assembly
	4000-403	Front Panel Assembly
	4000-407	Rear Panel Assembly
	4000-408	Heatsink Spacer Assembly
A1	4000-714	PC Assembly, Mother Board
A4, A6	4000-401	Heatsink Assembly, Power Amplifier
	4000-088	Schematic, Top Assembly
A2	4000-700	PC Assembly, Filter
	4000-081	Schematic, Filter
A3	4000-724	PC Assembly, Preamplifier
	4000-093	Schematic, Preamplifier
	4000-709	PC Assembly, Power Amplifier
	4000-083	Schematic, Power Amplifier
	4000-715	PC Assembly, Phase Selector
	4000-086	Schematic, Phase Selector

SECTION I

GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration and maintenance of the California Instruments XP Series AC Power Sources Model 321XP, 651XP, 971XP amd 1301XP.

1.2 SPECIFICATIONS

Table 1-1 contains the operating specifications for XP Series power sources. All specifications are tested in accordance with standard California Instruments test procedures and apply with a stable, low distortion input signal as generated by any XP-series oscillator/power controller. The following specifications apply for operation from 78% to 100% of full scale output voltage.

TABLE 1-1 SPECIFICATIONS
XP-SERIES POWER SOURCE

MODEL	321XP	651XP	971XP	1301XP
MAXIMUM OUTPUT POWER, VA				
@ TA=25 degrees C, 77.8% of Range 0.7 Power Factor	325	650	975	1,300
@ TA=25 degrees C, 100% of Range 0.7 Power Factor	419	836	1,252	1,671
@ TA=55 degrees C, 77.8% of Ramge 0.7 Power Factor	250	500	750	1,000
@ TA=55 degrees C, 100% of Range 0.7 Power Factor	321	642	964	1,285
MAXIMUM OUTPUT CURRENT, Arms				
@ TA=25 degrees C				
67.5 Volt Range	6.19	12.38	18.56	24.76
135 Volt Range	3.10	6.19	9.28	12.38
270 Volt Range	1.55	3.10	4.64	6.19
@ TA=55 degrees C				
67.5 Volt Range	4.76	9.52	14.28	19.04
135 Volt Range	2.38	4.76	7.14	9.52
270 Volt Range	1.19	2.38	3.57	4.76

OUTPUT VOLTAGE RANGES:	0-135 volts rms 0-270 volts rms
OPTIONAL:	0-67.5 volts rms 0-135 volts rms Voltage range selectable by front panel range key or via IEEE-488 bus when used with the XP-series programmable oscillators/AC power controllers.
LOAD REGULATION:	±1% over the range from 45 Hz to 5 KHz when tested at unity power factor.
TOTAL HARMONIC DISTORTION:	Less than 0.5% from 45 Hz to 5 KHz.
LINE REGULATION:	±0.1% of full output for a ±10% line change.
AMPLITUDE STABILITY:	±0.25% for 24 hours at constant line, load and ambient temperature.
FULL POWER FREQUENCY RANGE:	45 Hz to 5 KHz (Optional 15 Hz at derated power, 33% voltage and 30% power).
FREQUENCY RESPONSE:	±0.5dB 45 Hz to 5 KHz.
PHASE MATCHING: (Between identical power source models)	±1.5 degrees 45 to 2KHz. ±.5 degree/KHz. Does not include phase inaccuracy of oscillator drive signals.
EFFICIENCY:	321XP 651XP 971XP 1301XP 43% 52% 55% 53% at full power out at 135V at unity power factor
AC NOISE LEVEL:	70dB rms below full rms output with shorted input. 60dB below full peak-to-peak output with shorted input. 50dB below full peak-to-peak output at full rated power output.

OVERLOAD/SHORT CIRCUIT OVERPOWER PROTECTION:	A fault resulting from overloading, short circuit or overpower condition will cause an "OVERLOAD" indicator to illuminate on the front panel. The output voltage will then be clipped on the peaks. Clipping will be proportional to the amount of the overload.
OVERTEMPERATURE PROTECTION:	Thermal overload resulting from excessive heatsink temperature will cause an "OVERTEMP" indicator to illuminate on the front panel and the output voltage will drop to zero.
AMPLIFIER DRIVE: (normally obtained from plug-in oscillator through Power Monitor)	5 volts rms (typical) produces full scale output.
PROGRAMMABLE CURRENT LIMIT OPTION:	Current Limit programming is in peak amperes. The accuracy is ±5% of programmed value from 10% to 100% of rated output.
AC MAINS INPUT:	Models 321XP and 651XP normally wired for 103 to 135 VAC. Models 971XP and 1301XP normally wired for 180 to 253 VAC.
	The AC INPUT may be rewired for any of the three input ranges, 103 to 135 VAC, 180 to 253 VAC or 207 to 270 VAC. NOTE: When rewired the AC input check Table 2-3 for the correct circuit breaker.
AC MAINS FREQUENCY:	48 Hz to 65 Hz.
OPERATING TEMPERATURE RANGE:	0 to 55 degrees C.
STORAGE TEMPERATURE RANGE:	-25 degrees to 85 degrees C.
ACOUSTIC NOISE:	Less than 60 dB maximum when mounted in equipment rack measured three feet from front center, "A" weighted scale.

FRONT PANEL METER: (For Power Monitor specifications, refer to applicable Power Monitor Instruction Manual)	Monitors output voltage or load current. Resolution is 1 volt or 0.1 ampere. With "kiloWatts" option resolution is 10 watts.
FRONT PANEL INDICATORS:	"POWER ON" "RANGE" "OVERLOAD" "OVERTEMP"
FRONT PANEL CONTROLS:	
Amplifier:	Main Circuit Breaker
Power Monitor:	Range; IMB, IMC Volts; IMB, IMC Amp: IMB, IMC KiloWatt; IMC
INPUT/OUTPUT CONNECTORS:	AC MAINS INPUT provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Servo Sense inputs for individual phases provided on Amp cap 1-480701-0 w/Amp Socket Contact 350689-1. The mating connector is Amp plug 1-480700-0 w/Amp contact pin 350547-1. Interfacing in a multi-phase system is provided with the California Instrument cable assembly 4000-427. The power source connector is Amp 552118-1. The mating connector is Amphenol 57-20500-15.

INPUT/OUTPUT CONNECTORS: (continued)	Oscillator/Control signals for programmable oscillators are provided on rear mounted IEEE-488 (GPIB) connector 3M 3549-1000.
DIMENSIONS: (in inches)	1301XP - 19W - 22D - 7.00H 971XP - 19W - 22D - 7.00H 651XP - 19W - 22D - 5.25H 321XP - 19W - 22D - 5.25H
NET WEIGHT:	1301XP 103 Pounds 971XP 92 Pounds 651XP 78 Pounds 321XP 59 Pounds
SHIPPING WEIGHT:	1301XP 131 Pounds 971XP 128 Pounds 651XP 114 Pounds 321XP 93 Pounds
FRONT PANEL FINISH:	Gray, 26440 per federal standard 595 with black silk-screened lettering.

XP SERIES AC POWER SOURCE

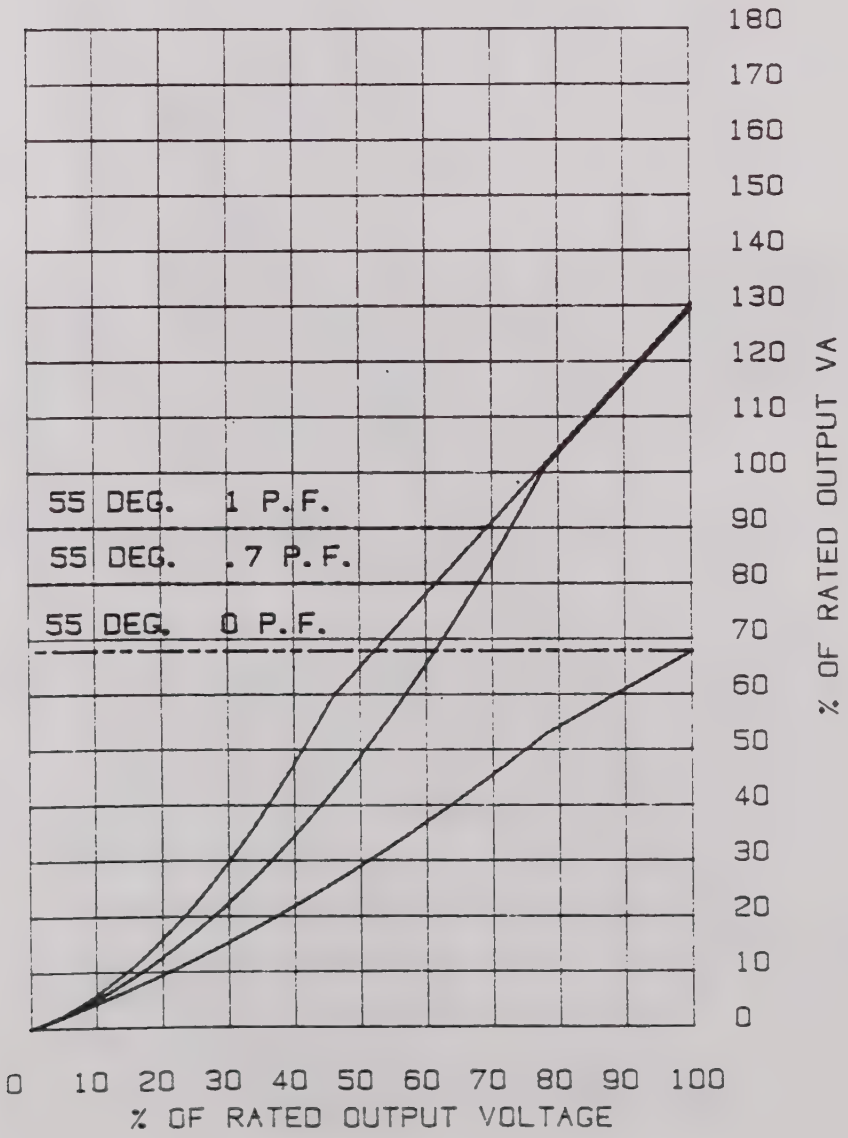
OUTPUT POWER CURVES

MODEL 321XP, 100% RATED POWER IS 250VA

MODEL 651XP, 100% RATED POWER IS 500VA

MODEL 971XP, 100% RATED POWER IS 750VA

MODEL 1301XP, 100% RATED POWER IS 1000VA



XP SERIES AC POWER SOURCE

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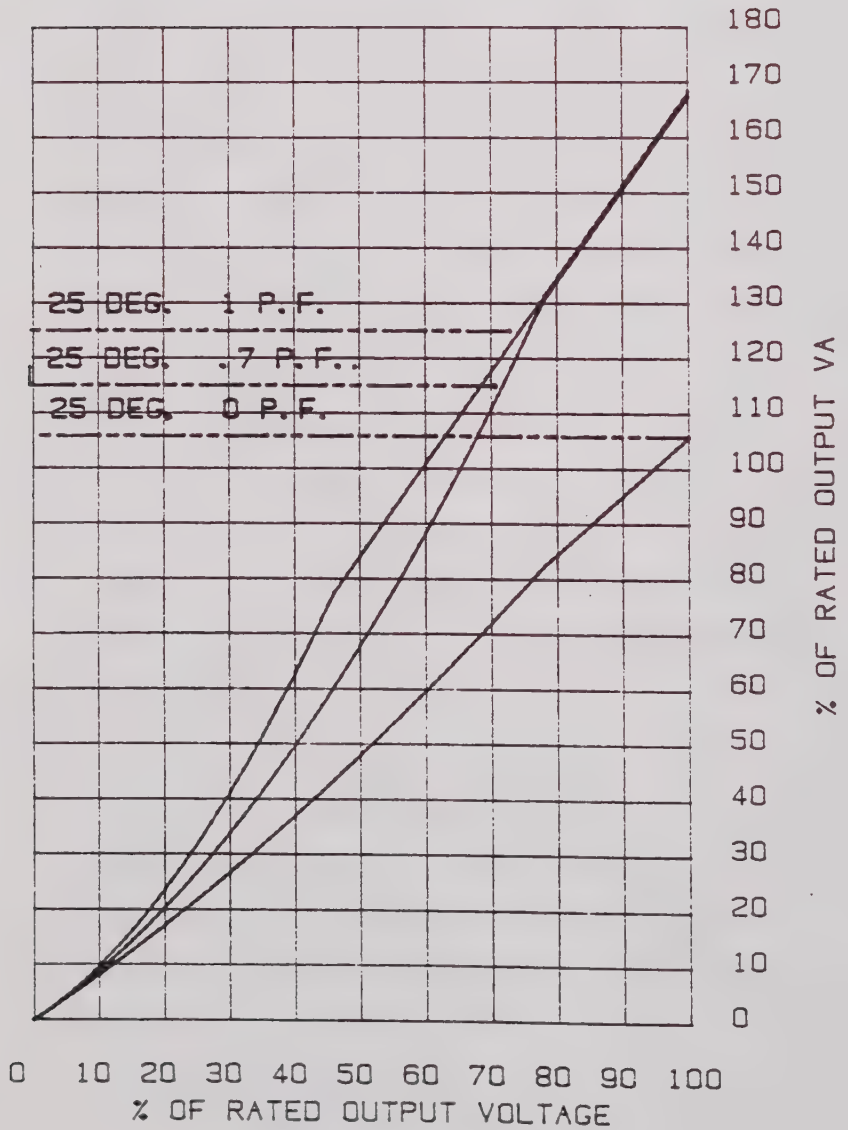

1.3 GENERAL DESCRIPTION

The California Instruments XP Series AC Power Amplifiers are solid state, high performance, low distortion power sources that provide up to 1670 VA output when used with the proper plug-in oscillator/power controller. The XP Series AC Power Sources are illustrated in Figures 1-1-1 thru 1-1-4. Full power output is available in two voltage ranges and over the frequency range from 45 Hz to 5 KHz.

1) 105 to 135 volts rms for normal single phase 115 volt applications.

2) 210 to 270 volts rms for normal single phase 230 volt applications.

Optional:

3) 52.5 to 67.5 volts rms for single phase low AC voltage applications.

4) 105 to 135 volts rms for normal single phase 115 volt applications.

For two-phase or three-phase operation, at least two power amplifiers must be combined together with the applicable multi-phase oscillator/power controller. For available output VA from two power sources in two-phase configuration and three-phase open DELTA configuration, and three power sources in three-phase WYE configuration, refer to Table 2-7.

1.4 ACCESSORY EQUIPMENT

The following accessories are available for use with the California Instruments XP Series AC Power Sources.

1.4.1 Rack Slides

Zero Manufacturing Company Model CTN-120 rack slides may be bolted directly to the sides of the unit.

1.4.2 Oscillators and Power Controllers

The 900 Series of manual oscillators include three separate models. These are:

1) 910XP oscillator with fixed frequency.

2) 913XP oscillator with three separate operation frequencies.

3) 920XP oscillator.

Additional power controllers and oscillators may be used with the XP Series Power sources. They are briefly described in the following paragraphs.

The 948XP AC Power Controller is a microprocessor controlled plug-in module which interfaces with the IEEE-488 GPIB. Programming and local control of the power controller/power source combination are accomplished via the front panel keyboard of the power controller.

The 949XP AC Power Controller is a self-contained, microprocessor controlled plug-in module that allows independent programming of amplitude, phase angle, current limit and frequency via the IEEE-488 GPIB. Local control is via a front panel keyboard.

1.4.3 Power Monitors

The Power Monitor is a plug-in unit designed for use with the XP Series AC Power Sources. The front panel of the monitor contains a digital LED display that reads out either Volts, Amps or kiloWatts. Additionally, the front panel contains a separate overtemperature LED and a separate overload indicator LED. The range key located on the front panel is used to change the output range of the power source. Output range may also be remotely changed through the oscillator/AC power controller. Output voltage amplitude may be adjusted remotely through the oscillator/AC power controller.

Any one of three functions may be selected either locally using the front panel keys or remotely selected through the oscillator-/AC power controller. In a three-phase system, the phase selection is done only remotely through the oscillator/AC power controller. The various versions of the Power Monitors that are available are explained in the following paragraphs.

1.4.3.1 IMA

IMA has no display and no function selection features. Overtemperature and overload indicator LEDs are available on the front panel. High range for the power source is indicated by an LED (illuminated when on Hi). Output voltage amplitude may be adjusted remotely through the oscillator/AC Power Controller. Output range of the power source may only be changed remotely through the AC power controller installed in the power source.

1.4.3.2 IMB1

IMB1 Power Monitor contains all the features described in paragraph 1.4.3 with the exception that it will display only Volts or Amps.

1.4.3.3 IMC1

IMC1 Power Monitor contains all the features described in paragraph 1.4.3.

REVISIONS			
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B	REVISED RACK SLIDES	7/87	

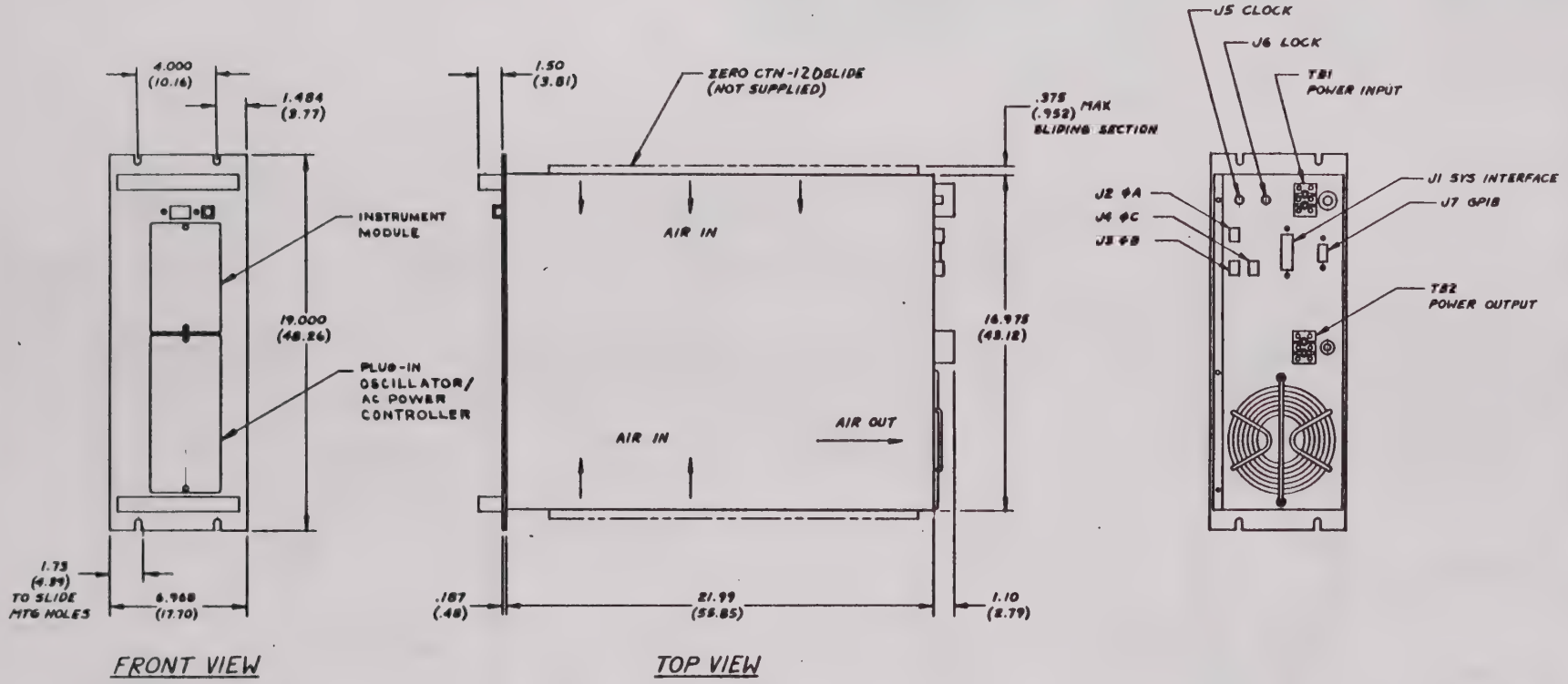

FIGURE 1-1-1

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

DIM IN INCHES
TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

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FINISH

TITLE: OUTLINE DRAWING
1301XP

			ADDITIONAL APPROVALS
RELEASE	R Belgard	4/5/85	
PROJ ENG	J. ROWE	3-28-85	
CHECK	BENNETT	4/4/85	
DESIGN			
DRAFT	AJROBERTO	14 MAR 85	

California Instruments
A DIVISION OF
AMBTAR TECHNICAL PRODUCTS CO., INC
SAN DIEGO, CALIFORNIA

CONTRACT NO
CODE IDENT 16067
DWG NO 4000-902
REV B
SCALE 1/4
SHEET 1 OF 1

QTY REQD	USED ON	NEXT ASSY

2. DIMENSIONS IN PARENTHESES ARE IN CENTIMETERS
1. FRONT PANEL DIMENSIONS PER E.I.A. STD RS-310

NOTES: (UNLESS OTHERWISE SPECIFIED)

4000-902 B

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
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B	REVISED RACK SLIDES	7/87	

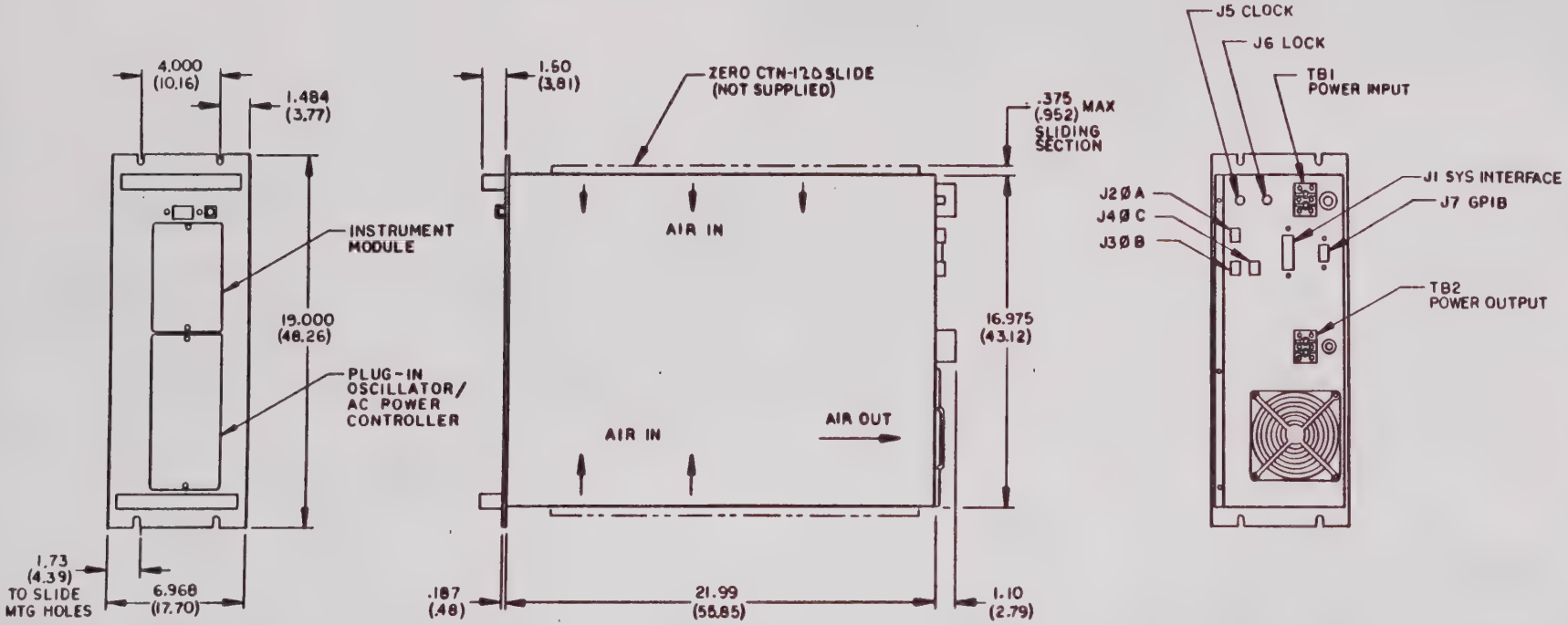

FIGURE 1-1-2

2. DIMENSIONS IN PARENTHESES ARE IN CENTIMETERS.
1. FRONT PANEL DIMENSIONS PER E.I.A. STD RS-310.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY

DIM IN INCHES
TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES

DWG SIZE C

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FINISH

TITLE
OUTLINE DRAWING
971XP

			ADDITIONAL APPROVALS
RELEASE	R. Bryant	5/31/85	
PROJ ENG	J. Rouse	5/31/85	
CHECK	Ernie	5/31/85	
DESIGN			
DRAFT	M. RICE		

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A	ADDED DESIGNATING CALLOUTS TO FRONT VIEW.	7/87	
B	REVISED RACK SLIDES	7/87	

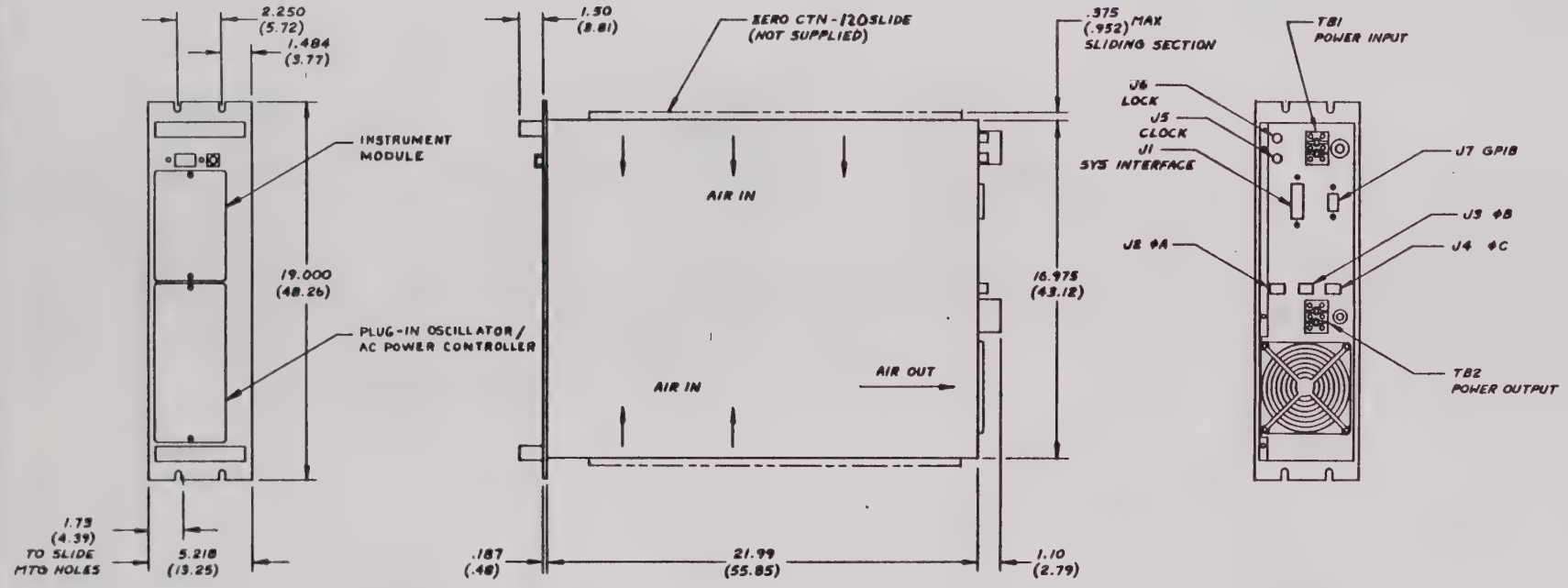

FIGURE 1-1-3

REQD PER ASSY	ITEM NO.	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

DIM IN INCHES
TOLERANCES
XXX ± 010
XX ± 03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

TITLE: OUTLINE DRAWING
321XP, 681XP

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FINISH

			ADDITIONAL APPROVALS
RELEASE	R Bedyard	3/25/85	
PROJ ENG	J. ROUSE	3-22-85	
CHECK	ERWHE	3/26/85	
DESIGN			
DRAFT	AJROBERTO	26MAR85	7/87

California Instruments
A DIVISION OF AMBTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO | CODE IDENT 16067

DWG NO 4000-901 | REV B

SCALE 1/4 | SHEET 1 OF 1

QTY REQD	USED ON	NEXT ASSY

2. DIMENSIONS IN PARENTHESES ARE IN CENTIMETERS
1. FRONT PANEL DIMENSIONS PER E.I.A. STD RS-310

NOTES: (UNLESS OTHERWISE SPECIFIED)

4000-901 B

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ADDED DESIGNATING CALLOUTS TO FRONT VIEW. 4/21/85		
B	REVISED RACK SLIDES	7/87	

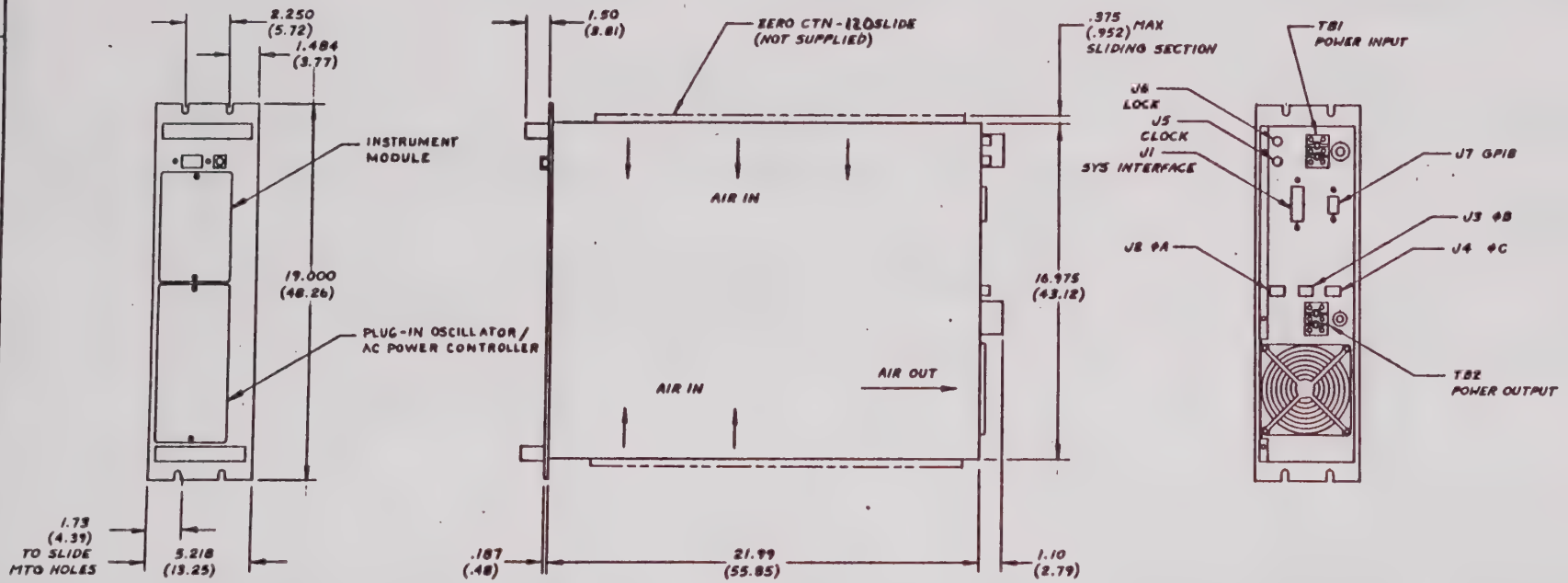

FIGURE 1-1-4

ITEM NO.	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO.

REQD PER ASSY

LIST OF MATERIAL

DIM IN INCHES TOLERANCES .XXX ± .010 .XX ± .03 X° ± 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE C

TITLE: OUTLINE DRAWING 92IXP, 68IXP

California Instruments — A DIVISION OF AMBTAR TECHNICAL PRODUCTS CO., INC. SAN DIEGO, CALIFORNIA

			ADDITIONAL APPROVALS
RELEASE	R Bedgood	3/25/85	
PROJ ENG	J. ROUSE	3-22-85	
CHECK	ERWINE	3/26/85	

CONTRACT NO | CODE IDENT 16067

DWG NO 4000-901 | REV B

FINISH

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2. DIMENSIONS IN PARENTHESES ARE IN CENTIMETERS
1. FRONT PANEL DIMENSIONS PER E.I.A. STD RS-310

WARNING

HIGH VOLTAGE (270 VAC)

Voltages up to 270 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with the primary power circuits, and the output circuits of the power source.

SECTION II

INSTALLATION AND OPERATION

2.1 UNPACKING

The California Instruments XP Series Power Source is shipped in a cardboard container with protective inner packing. Do not destroy the packing container until the unit has been inspected for possible damage in shipment.

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. If the unit appears in good condition, perform the following.

2.2 POWER REQUIREMENTS

2.2.1 AC Line Voltage Input Connections

The XP Series Power Sources have been designed to operate from any one of the following AC line voltages RANGES:

1) 103 to 135 volts
2) 180 to 253 volts
3) 207 to 270 volts

The input power transformer is normally wired at the factory to operate from range 1 AC line voltage for the 321XP and 651XP power sources. The input power transformer is wired to operate from range 3 AC line voltage for the 971XP and 1301XP power sources. Table 2-3 lists the primary power transformer connections for various AC input line voltages. Figure 2-1 shows the jumper connections for TB3, AC input selector.

2.2.2 Line Frequency Operating Range

The XP Series AC Power Source has been designed to operate over the line frequency range from 48 to 65 Hz.

TABLE 2-1
INPUT POWER FOR XP SERIES POWER SOURCES

MODEL	1301XP	971XP	651XP	321XP
Input Power (Watts)	160 to 3120	105 to 2270	105 to 1600	105 to 960

2.2.3 Input Power

The input power, minimum and maximum, depending on line and load conditions is shown in Table 2-1 for different XP power sources.

2.3 CIRCUIT BREAKER REQUIREMENTS

The XP Series AC Power Sources use selected circuit breakers for these units. Different circuit breakers are used in each unit for either low or high AC line voltages. Table 2-2 shows the correct circuit breaker application for each XP Series AC Power Source. Substitution of the circuit breaker type or current rating may cause permanent damage to the unit.

Low AC line voltages: RNG 1: 103 to 135 VAC

High AC line voltages: RNG 2: 180 to 253 VAC
RNG 3: 207 to 270 VAC

TABLE 2-2 XP SERIES CIRCUIT BREAKERS

CIRCUIT BREAKER CURRENT RATING	AIRPAX PART NUMBER	XP POWER SOURCE USING CIRCUIT BREAKER
50 Amperes	APGX-66-1-65-503-H-21 CI stock #: 270116	1301XP at RNG 1 of line voltage.
40 Amperes	APGX-66-1-65-403-H-21 CI stock #: 270115	971XP at RNG 1 of line voltage.
35 Amperes	APGX-66-1-65-353-H-21 CI stock #: 270114	1301XP at RNG 2 and RNG 3 of line voltage
25 Amperes	UPGX-66-1-65-253-H-21 CI stock #: 270113	651XP at RNG 1 of line voltage. 971XP at RNG 2 and RNG 3 of line voltage
18 Amperes	UPGX-66-1-65-183-H-21 CI stock #: 270111	651XP at RNG 2 and RNG 3 of line voltage 321XP at RNG 1 of line voltage.
10 Amperes	UPGX-66-1-65-103-H-21 CI stock #: 270110	321XP at RNG 2 and RNG 3 of line voltage

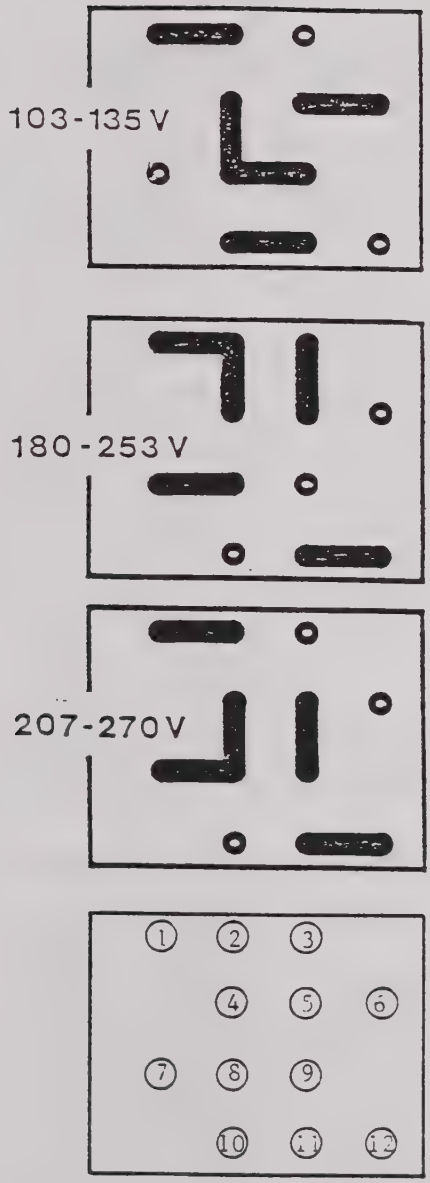


FIGURE 2-1

AC VOLTAGE SELECTOR BOARD, JUMPER CONNECTIONS FOR VARIOUS AC INPUT LINE VOLTAGES

Table 2-3 Power Transformer Connections for Various AC Input Line Voltages

NOTE Prior to reconnecting power transformer, T1, remove all existing jumpers from the voltage selector board. Please refer to Figure 2-1 or the cover for TB3.			
NOMINAL INPUT VALTAGE	OPERATING LINE VOLTAGE RANGE	VOLTAGE SELECTOR BOARD CONNECTIONS	FRONT PANEL CIRCUIT BREAKER VALUE
115 volts rms	103-135 volts rms	jumper pins 1 and 2; jumper pins 5 and 6; jumper pins 4 and 8; jumper pins 8 and 9; jumper pins 10 and 11.	50 ampere for 1301XP; 40 ampere for 971XP; 25 ampere for 651XP; 18 ampere for 321XP
208-220 volts rms	180-253 volts rms	jumper pins 1 and 2; jumper pins 2 and 4; jumper pins 3 and 5; jumper pins 7 and 8; jumper pins 11 and 12.	35 ampere for 1301XP; 25 ampere for 971XP; 18 ampere for 651XP; 10 ampere for 321XP
230-240 volts rms	207-270 volts rms	jumper pins 1 and 2; jumper pins 4 and 8; jumper pins 7 and 8; jumper pins 5 and 9; jumper pins 11 and 12.	35 ampere for 1301XP; 25 ampere for 971XP; 18 ampere for 651XP; 10 ampere for 321XP

2.4 OUTPUT VOLTAGE RANGES

Two output voltage range pairs (high and low) are incorporated in the XP Series Power Sources. The range pairs are:

1) 0 to 135 volts and 0 to 270 volts or
2) 0 to 67.5 volts and 0 to 135 volts

For different voltage range pairs connect the output transformer (T2) jumpers at its output as follows:

135/270 volts range: T2-6 to 7 and 10 to 11
67.5/135 volts range: T2-5 to 7, 6 to 8, 9 to 11 and 10 to 12.

Selection of the proper output voltage range can be accomplished remotely or locally. Remote selection is accomplished via the IEEE-488 GPIB using a programmable oscillator/power controller. Local selection is accomplished by using the front panel range key of the power monitor used in that power source. Refer to the appropriate power monitor manual for instructions on changing the range. When the XP Series AC Power Sources are switched to the high range of either range pair, the LED inside the front panel range key illuminates. When using a programmable oscillator/power controller, refer to the instruction manual when attempting a change of range pairs.

CAUTION:

Before a range change is made, verify that the output voltage and load are compatible and within the VA ratings of the unit or damage to the load may occur.

2.5 FRONT PANEL CONTROLS

2.5.1 Circuit Breaker

The circuit breaker, located on the front panel of the XP Series Power Source, is used to switch the POWER to the unit. When the circuit breaker is switched to ON, the amber indicator lamp located above the circuit breaker illuminates.

2.5.2 Additional Controls

All additional front panel controls are located on the power monitor or oscillator/power controller. Refer to the appropriate manual.

2.6 ACCEPTANCE TEST PROCEDURE

2.6.1 Initial Set-up

1. Refer to Figure 4-3 for recommended test setup. Ensure that the AC MAINS are of the proper voltage and frequency as determined by either the serial number tag on the unit or by inspection of the wiring to the primary of the power transformer (see Section 2.2 of the instruction manual). Use number 10 wire to connect the AC power line to the AC input terminals at the rear of the unit if the unit is being operated from the 103 volt through 135 volt AC power line.

2. Connect a 5 KW autotransformer and a 5 KW power analyzer in series with the AC line.

3. Set the 5 KW autotransformer to the required line voltage (See Table 2-3).

2.6.2 Power On

1. Apply AC line power to the power source.

2. Apply input power to the XP Series power source by setting the front panel circuit breaker to the "ON" position.

3. Verify that the power source draws less than 170 watts with the AC MAINS set to midline for the AC input range selected.

2.6.3 Set-up for Load/Overload Test

1. For test setup, refer to Figure 4-3. For recommended test equipment please refer to section 4.2.

2. Using either a California Instruments 900 Series manual oscillator or a suitable external low distortion sine wave generator, set the oscillator to the desired frequency between 45 Hz and 5 KHz and set the phase selector switch to phase A If an external oscillator is used, apply the AC input signal to J1, pins 26 and 1 (high and low, respectively).

3. Determine the voltage range pair to be tested, reference paragraph 2.4. Connect proper load resistors per Tables 2-4-1 through 2-4-4 and Figure 4-3.

TABLE 2-4-1

OUTPUT VOLTAGE AND LOAD VALUES FOR 1301XP

OUTPUT VOLTAGE RANGE	OUTPUT VOLTAGE	FULL POWER LOAD RESISTANCE		50 PERCENT POWER LOAD RESISTANCE	
		TA=25 C	TA=55 C	TA=25 C	TA=55 C
0-67.5 Volts	67.5 Volts rms	2.7	3.5	5.4	7.1
0-135 Volts	135 Volts rms	10.9	14.2	21.8	28.4
0-270 Volts	270 Volts rms	43.6	56.7	87.2	113.4

NOTE: All resistors are in ohms

TABLE 2-4-2

OUTPUT VOLTAGE AND LOAD VALUES FOR 971XP

OUTPUT VOLTAGE RANGE	OUTPUT VOLTAGE	FULL POWER LOAD RESISTANCE		50 PERCENT POWER LOAD RESISTANCE	
		TA=25 C	TA=55 C	TA=25 C	TA=55 C
0-67.5 Volts	67.5 Volts rms	3.6	4.7	7.3	9.4
0-135 Volts	135 Volts rms	14.5	18.9	29.1	37.8
0-270 Volts	270 Volts rms	58.1	75.6	116.3	151.2

NOTE: All resistors are in ohms

TABLE 2-4-3

OUTPUT VOLTAGE AND LOAD VALUES FOR 651XP

OUTPUT VOLTAGE RANGE	OUTPUT VOLTAGE	FULL POWER LOAD RESISTANCE		50 PERCENT POWER LOAD RESISTANCE	
		TA=25 C	TA=55 C	TA=25 C	TA=55 C
0-67.5 Volts	67.5 Volts rms	5.4	7.1	10.9	14.2
0-135 Volts	135 Volts rms	21.8	28.3	43.6	56.7
0-270 Volts	270 Volts rms	87.2	113.4	174.4	226.8

NOTE: All resistors are in ohms

TABLE 2-4-4

OUTPUT VOLTAGE AND LOAD VALUES FOR 321XP

OUTPUT VOLTAGE RANGE	OUTPUT VOLTAGE	FULL POWER LOAD RESISTANCE		50 PERCENT POWER LOAD RESISTANCE	
		TA=25 C	TA=55 C	TA=25 C	TA=55 C
0-67.5 Volts	67.5 Volts rms	10.9	14.2	21.8	28.4
0-135 Volts	135 Volts rms	43.6	56.7	87.2	113.4
0-270 Volts	270 Volts rms	174.5	226.8	348.9	453.6

NOTE: All resistors are in ohms

2.6.4 Load Test

1. Using the AMPLITUDE control on the oscillator, set the output voltage to the rated voltage of the unit. Apply full load per Tables 2-4-1 to 2-4-4.

2. Verify that the output voltage is within ±1% of the no load voltage set in step 1.

3. Verify that there is no peak clipping as observed on the oscilloscope or that the measured distortion is less than 1% THD.

2.6.5 Overload Test

1. With the output still adjusted as determined in 2.6.4, place a 50% load resistor in parallel with the external load resistor to provide a 50% overload at the output of the power source; the value of this resistor is given in Tables 2-4-1 through 2-4-4 of this manual.

2. Verify that the signal on the oscilloscope exhibits significant clipping on both the positive and negative peaks indicating that the unit is in a limiting condition. The OVERLOAD lamp on the front panel should light.

3. Remove the 50 percent overload resistor. The output should return to normal and the OVERLOAD lamp should extinguish.

4. Place a short circuit in parallel with the external load resistor and then remove the short circuit after a few moments. The signal on the oscilloscope should go to zero and then return to normal when the short circuit is removed.

2.6.6 Extended Testing

1. Section 2.6.1 thru 2.6.5 may be repeated for any output frequency between 45 Hz and 5 KHz.

2. Section 2.6.1 thru 2.6.5 may be repeated on any of the output voltage ranges. See Tables 2-4-1 through 2-4-4 for voltage and load values.

3. The Calibration Procedure in Section IV of this manual should be used if more detailed evaluation of the XP Series power source is required.

2.7 MECHANICAL INSTALLATION

The XP Series AC Power Sources have been designed for rack mounting in a standard 19 inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with a pair of rack slides (Zero Manufacturing type CTN-120 or equivalent).

The cooling fan on the rear of the unit must be free of any obstructions which would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the fans and the rear door of the mounting cabinet. Also, the air intake holes on the sides and bottom of the power source must not be obstructed.

For bench top use, the power source is supplied with removable feet. The area under the unit must be kept clear to allow for air circulation.

2.8 INPUT POWER WIRING

The XP Series Power Source will operate from single phase input voltages from 103 volts to 270 volts rms in three ranges as described in Section 2.2 of this manual. The MAINS source should have an ampacity rating equal or greater than the circuit breaker requirement for the power source. Refer to Table 2-2 for power source circuit breaker requirements.

2.9 OUTPUT POWER WIRING

The power output wires should be large enough to avoid excessive line voltage drops. It is necessary that line drops be limited to approximately 1 to 2 percent of the required output voltage. Tables 2-5-1 through 2-5-4 list the minimum acceptable wire gauges for the different XP Series AC Power Sources for a 1.0 percent line drop. This drop is due to only resistive loss at low frequencies up to 400 Hz. At higher frequencies the line drop can be higher due to reactive losses.

CAUTION

The wire sizes specified in Tables 2-5-1 through 2-5-4 are only for single wire use and reflect the MINIMUM wire size required. If wires are bundled or in confined spaces, the wire sizes should be doubled.

2.10 DELTA AND WYE HOOKUP

Using the applicable multi-phase oscillator/power controller, at least two power amplifiers may be combined to provide two-phase and three-phase operation. For the available output VA in each configuration, refer to Table 2-6. Figure 2-3 illustrates the open DELTA configuration. Figure 2-4 illustrates the three-phase WYE configuration. Figure 2-2 illustrates common 2-phase and 3-phase load connections that may be made using California Instruments AC power sources.

Any of the oscillators/power controllers described in Section 1.4.2 may be used to control either the open DELTA or the WYE configuration. The configuration of these oscillator/controllers is usually set at the factory. Please contact the factory when attempting to change the configuration of non-phase programmable units.

2.11 POWER MONITOR VOLTAGE SENSE

If an oscillator in a three-phase system has no remote voltage sense capability, the sense connector (J2) at the rear side of each power source is connected to the output terminals (TB2) of the same unit. J2 is used both as a remote voltage sense input for phase A power source and also as a voltage sense input for the power monitor in all the power sources. If an oscillator in a three-phase system has remote voltage sense capability, J2 of each power source is connected to the corresponding load.

At least two power sources can be connected in series for each phase. In this case, the output "Low" of the first unit is connected to the output "High" of the second unit. The output "High" of the first unit and the output "Low" of the second unit are connected to the corresponding load.

TABLE 2-5-1

OUTPUT WIRING FOR 1301XP

OUTPUT VOLTAGE	MAXIMUM LINE DROP	MAXIMUM LOAD CURRENT	LOOP LENGTH	MINIMUM REQUIRED WIRE GAUGE
67.5 Volts	0.675 Volts	24.76 amps	20 feet	#14 wire
135 Volts	1.35 Volts	12.38 amps	20 feet	#18 wire
270 Volts	2.70 Volts	6.19 amps	20 feet	#22 wire

TABLE 2-5-2

OUTPUT WIRING FOR 971XP

OUTPUT VOLTAGE	MAXIMUM LINE DROP	MAXIMUM LOAD CURRENT	LOOP LENGTH	MINIMUM REQUIRED WIRE GAUGE
67.5 Volts	0.675 Volts	18.56 amps	20 feet	#16 wire
135 Volts	1.35 Volts	9.28 amps	20 feet	#20 wire
270 Volts	2.70 Volts	4.64 amps	20 feet	#24 wire

NOTE

The wire gauge should be reduced 3 gauges every time that the distance between the power source and load is doubled.

TABLE 2-5-3

OUTPUT WIRNG FOR 651XP

OUTPUT VOLTAGE	MAXIMUM LINE DROP	MAXIMUM LOAD CURRENT	LOOP LENGTH	MINIMUM REQUIRED WIRE GAUGE
67.5 Volts	0.675 Volts	12.38 amps	20 feet	#18 wire
135 Volts	1.35 Volts	6.19 amps	20 feet	#22 wire
270 Volts	2.70 Volts	3.1 amps	20 feet	#24 wire

TABLE 2-6-4

OUTPUT WIRING FOR 321XP

OUTPUT VOLTAGE	MAXIMUM LINE DROP	MAXIMUM LOAD CURRENT	LOOP LENGTH	MINIMUM REQUIRED WIRE GAUGE
67.5 Volts	0.675 Volts	6.19 amps	20 feet	#22 wire
135 Volts	1.35 Volts	3.1 amps	20 feet	#24 wire
270 Volts	2.70 Volts	1.55 amps	20 feet	#26 wire

NOTE

The wire gauge should be reduced 3 gauges every time that the distance between the power source and load is doubled.

TABLE 2-6-A

MULTI-PHASE OUTPUT VA VALUES
at TA=25 degrees C

UNIT	TOTAL SYSTEM OUTPUT			MAXIMUM LINE CURRENT (RMS)		
	VA FOR 2-PHASE	VA FOR 3-PHASE OPEN DELTA	VA FOR 3-PHASE WYE	67.5 V RANGE	135V RANGE	270V RANGE
1301XP	2600 VA	*2600 VA	3900 VA	24.76A	12.38A	6.19A
971XP	1950 VA	*1950 VA	2925 VA	18.57A	9.28A	4.64A
651XP	1300 VA	*1300 VA	1950 VA	12.38A	6.19A	3.15
321XP	650 VA	*650 VA	975 VA	6.19A	3.15	1.55A

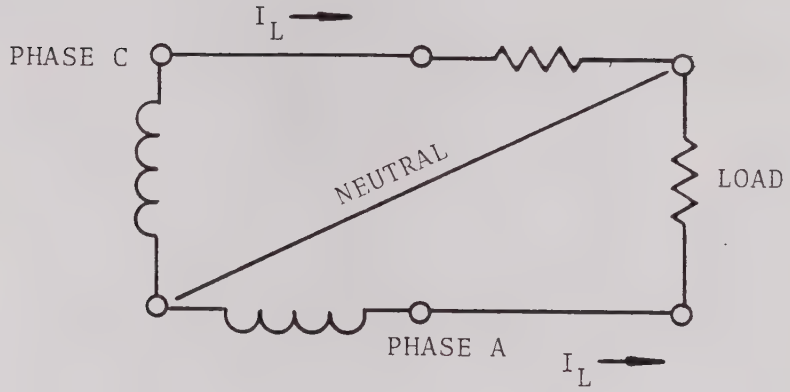
TABLE 2-6-B

MULTI-PHASE OUTPUT VA VALUES
at TA=55 degrees C

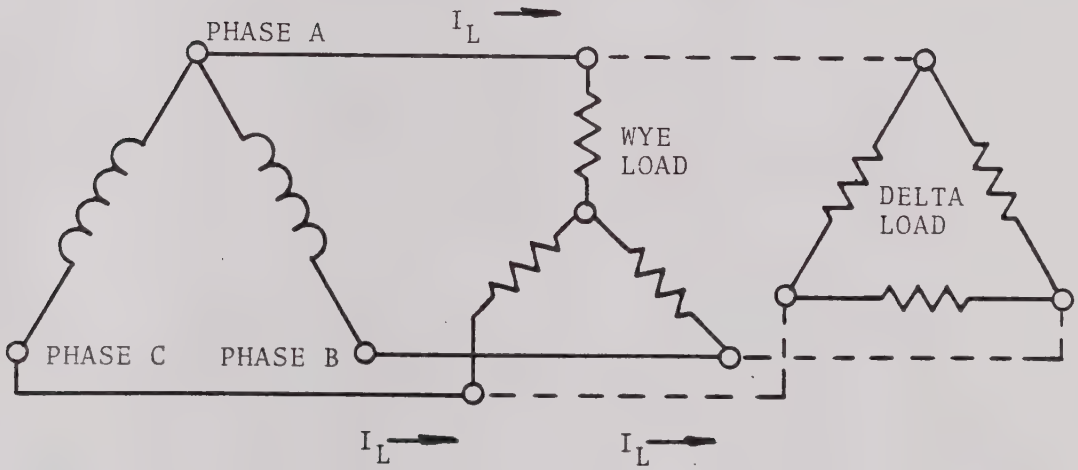
UNIT	TOTAL SYSTEM OUTPUT			MAXIMUM LINE CURRENT (RMS)		
	VA AT 2-PHASE	VA AT 3-PHASE OPEN DELTA	VA AT 3-PHASE WYE	67.5V RANGE	135V RANGE	270V RANGE
1301XP	2000 VA	*2000 VA	3000 VA	19A	9.52A	4.76A
971XP	1500 VA	*1500 VA	2250 VA	14.28A	7.14A	3.57A
651XP	1000 VA	*1000 VA	1500 VA	9.52A	4.76A	2.38A
321XP	500VA	*500VA	750VA	4.76A	2.38A	1.19A

*The effective power factor for each phase with a unity power factor load is 0.866.

Two-Phase 90° Connection



Three-Phase Open DELTA Connection



Three-Phase WYE Connection

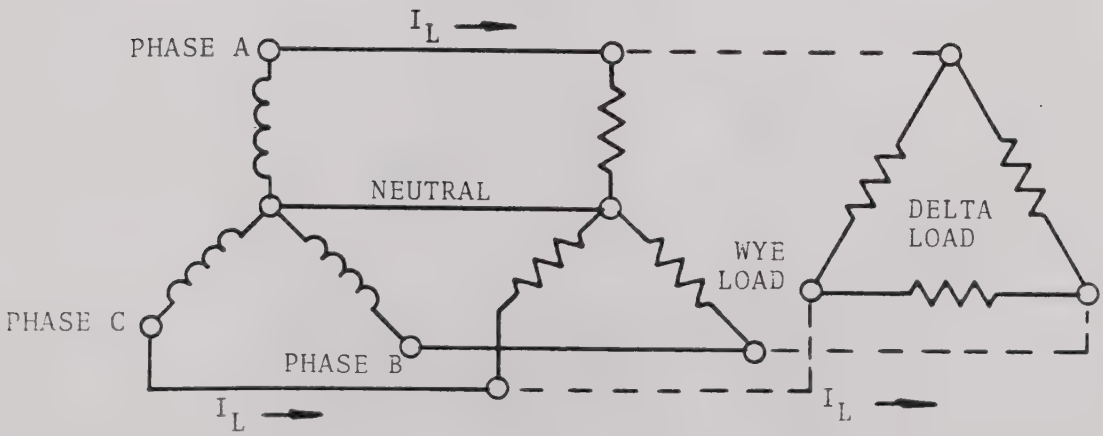


FIGURE 2-2
VARIOUS MULTI-PHASE SYSTEM CONNECTIONS

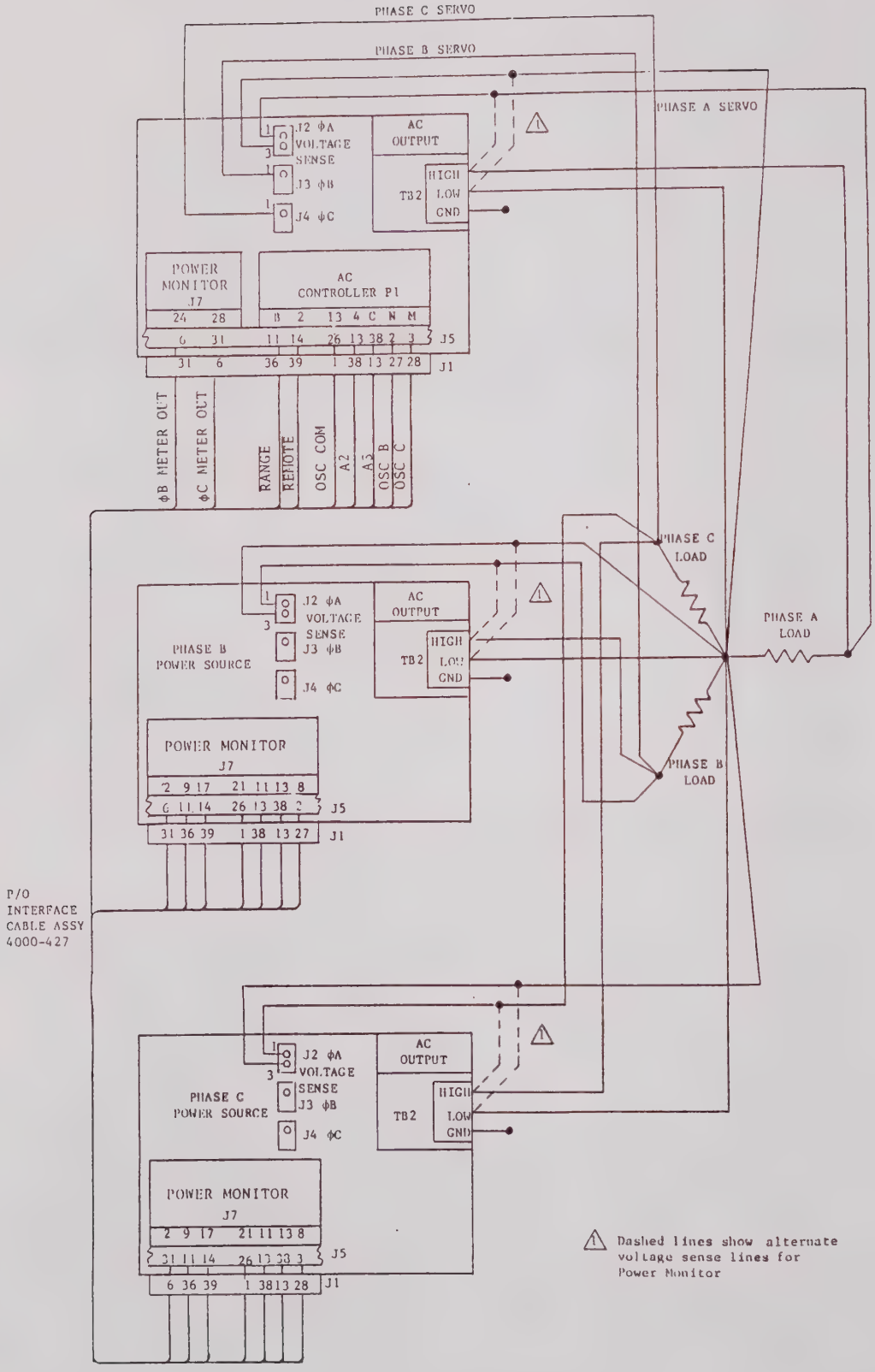


FIGURE 2-3 WYE HOOKUP XP-SERIES

THREE-PHASE POWER SOURCE SYSTEM CONNECTIONS USING THREE INDIVIDUAL UNITS

NOTE: SET THE PHASE SELECTOR IN EACH UNIT TO THE APPROPRIATE PHASE

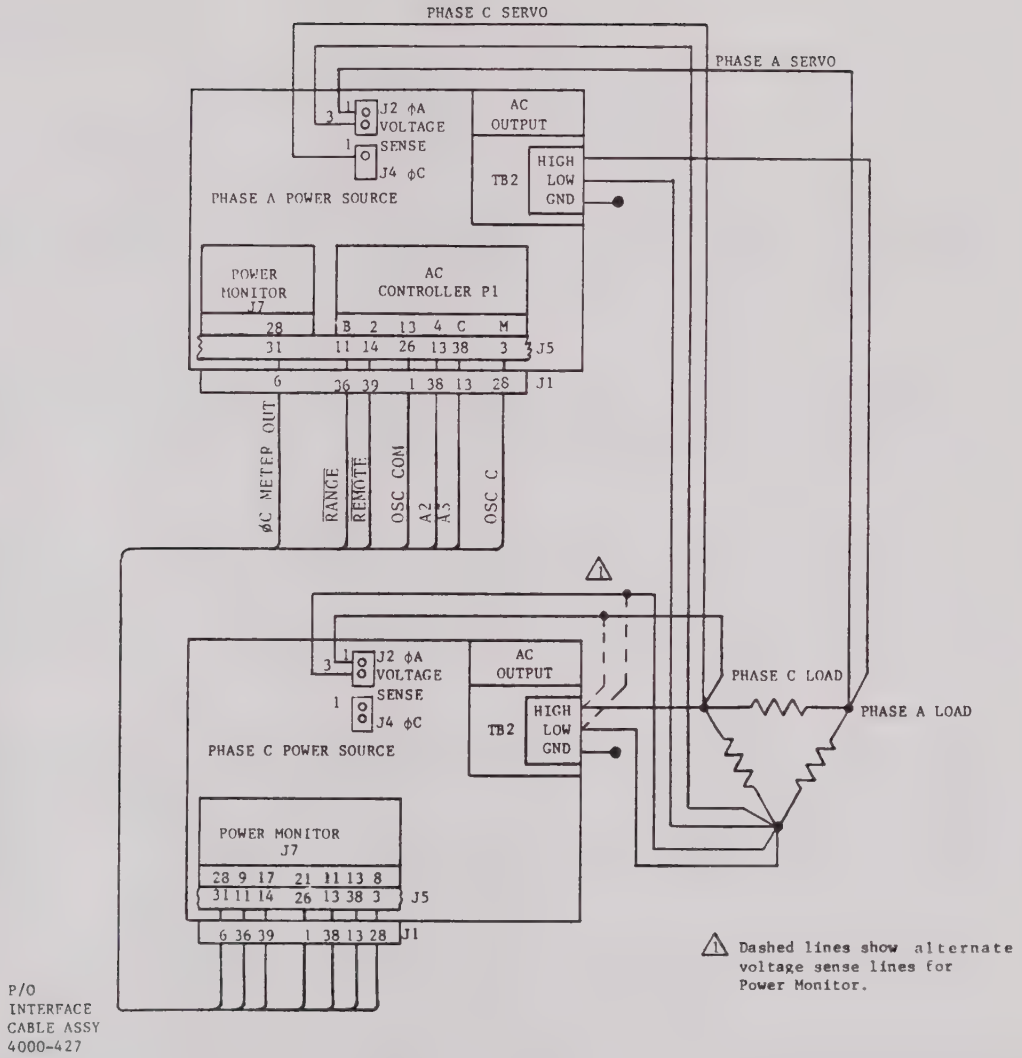


FIGURE 2-4
DELTA HOOK UP XP-SERIES
THREE-PHASE POWER SOURCE SYSTEM CONNECTIONS
USING TWO INDIVIDUAL UNITS

NOTE: SET THE PHASE SELECTOR IN EACH UNIT TO THE APPROPRIATE PHASE

SECTION III

THEORY OF OPERATION

3.1 GENERAL

The XP-Series power sources, 321XP, 651XP, 971XP and 1301XP, are amplifiers capable of providing from 418 VA up to 1670 VA of reliable sine wave AC power over the frequency range of 45 Hz to 5 KHz.

A block diagram of the power source is shown in Figure 3-1. The amplifier consists of preamplifier/power supply regulator, A3, a power amplifier made up of one or more heatsink assemblies, A4-A7, an output transformer, T2, with multiple secondaries and power supplies using T1, A2 and part of A3.

The preamplifier consisting of an error amplifier (G1) and level shifter (G2) is used to amplify the input signal to supply adequate drive to the power amplifier. The preamplifier main functions are voltage gain, DC level shifting and stability compensation. A block diagram of the preamplifier is shown in Figure 3-2.

The preamplifier board contains the circuits for protection against any power supply fault, overpower, overcurrent and overtemperature conditions. This board also contains a programmable current limit circuit to program the maximum allowable output current and a temperature sense circuit to adjust allowable output power as a function of ambient temperature.

The preamplifier board also contains the regulation control circuit which is used to compensate for losses.

A low-pass filter is located at the input of the preamplifier to prevent driving the amplifier with frequencies in excess of the rated full power frequency.

The power amplifier provides the necessary sine wave signal to drive the output transformer. The power amplifier consists of one or more heatsink modules.

The rated VA output of the power source is, to a large extent, determined by the power dissipation in the quasi-complementary symmetry output stage. The power dissipation is determined by the power factor of the load, the load impedance, and by the output voltage. The power rating chart, in the specifications at the front of the manual, expresses this rating in a graphical form.

The output transformer has floating secondary windings which allow the load to float from the amplifier and oscillator circuitry.

The four 67.5 volts secondary windings of the output transformer are connected in parallel for 0 to 67.5 volts range output, series-parallel for 0 to 135 volts range output and in series for 0 to 270 volts range output. The transformer output ranges are selected through a combination of transformer jumpers and a range relay. When the power source is delivering its full rated output voltage, at 400 Hz, the output transformer has approximately 39.7 volts rms across the primary.

The overall negative feedback is taken from the primary winding of T2 back to the non-inverting input of the preamplifier.

3.2 Detailed Circuit Description

A chassis level schematic diagram for the Model XP Series Power Source is shown in drawing 4000-088. All components not mounted directly on the chassis assembly, are designated as parts of a circuit board assembly or a heatsink module assembly. Tables 3-2 to 3-4 list the circuit board assemblies by their designators for the different XP-Series power sources.

All other components are a part of the top assembly. For information on the plug-in oscillator/power controller, consult the appropriate manual. For information on the plug-in power monitor, consult the appropriate manual.

3.2.1 Input Filter

The input filter on the preamplifier board is a two-pole active low-pass filter comprised of one half of A3U9 and associated components. This filter is used to attenuate high frequency noises or signals applied to the preamplifier.

3.2.2 Preamplifier (G1, G2)

The preamplifier is the primary interface between the oscillator/power controller and the power amplifier. It consists of two major sections, an error amplifier (G1) and a level shifter (G2). The primary active element of G1 is the operational amplifier, A3U16. The gain of this stage is set by A3R115 and A3R110.

The second stage of the preamplifier, G2, consists of A3Q11 through A3Q21 and associated components. The gain of G2 is set by A3R122 and A3R141. Frequency compensation is provided by A3R140 and A3C55.

Protection against power supply faults of either the ±15 VDC or ±68 VDC supplies is provided by A3Q11 through A3Q14 and associated components.

Proper biasing of the power amplifier (G3) is provided by Vbe multiplier A3Q19 with A3R144 and A3R145.

3.2.3 Power Amplifier (G3)

The power amplifier (G3) consists of A3Q25 and A3Q26 and various combinations of heatsink modules A4, A5, A6 or A7. Refer to Table 3-1 for the exact configuration of heatsink assemblies for a specific power source.

The power amplifier converts the differential output of the level shifter to a single ended output capable of driving the primary of the output transformer, T2.

Drive for the power amplifier heatsink assembles is provided by A3Q25 for the postive heatsink and A3Q26 for the negative heatsink.

The positive polarity drive to the output transformer is configured as an emitter follower and provides a total of 67 amperes peak for the 1301XP units, a total of 50 amperes peak for the 971XP units, a total of 33 amperes peak for the 651XP units, and a total of 16.6 amperes peak for the 321XP units at 25 degrees C ambient, full load and 78% of rated output voltage.

These transistors supply a total of 51 amperes peak for the 1301XP units, a total of 38.5 amperes peak for the 971XP units, a total of 25.5 amperes peak for the 651XP units and a total of 12.75 amperes peak for the 321XP units during the positive half cycle of the output waveform at 55 degrees C ambient, full load and 78% of rated output voltage.

The negative polarity drive to the output transformer is connected in a quasi-complementary symmetry configuration. These transistors supply the same amount of current as the transistors in the positive heatsink at 25 and 55 degrees C ambient during the negative half cycle of the output waveform at full load and at 78% of rated output voltage.

TABLE 3-1

HEATSINK ASSEMBLIES FOR XP-SERIES POWER SOURCES

UNIT	HEATSINK ASSEMBLIES FOR POSITIVE HALF OF POWER AMPLIFIER	HEATSINK ASSEMBLIES FOR NEGATIVE HALF OF POWER AMPLIFIER
1301XP	Two each A4	One each A5, A6
971XP	One each A4 and Half of A7	One each A5 and Half of A7
651XP	One each A4	One each A6
321XP	Half of A7	Half of A7

3.2.4 Output Range Selection

Range selection is done via a combination of transformer jumpers and range change relay. The output transformer is comprised of four idential 67.5 volt secondaries.

The jumpers configure the transformer as having two 67.5 volt windings or two 135 volt windings. The range relay then either places these windings in parallel or series. The standard output transformer allows two range pairs, 67.5/135 or 135/270.

If using a servoed oscillator/power controller, refer to the oscillator/power controller manual before changing range pairs.

3.2.4.1 Range Relay Drive

The range relay is driven by A1Q1 current buffer with associated components. Buffer A1Q1 is, in turn, driven by the "RANGE DRIVE" output of the Power Monitor. This line is an active low for the "HI" range. The status of the "RANGE DRIVE" line is determined by either front panel HI RANGE switch with a manual oscillator or the programmed range selection of a power controller.

TABLE 3-2

CIRCUIT BOARD LISTING 1301XP

DESIGNATOR	ASSEMBLY NUMBER	SCHEMATIC	NAME
A1	4000-713-1	4000-088	PC ASSEMBLY, MOTHER BOARD
A2	4000-700-4	4000-081	PC ASSEMBLY, FILTER
A3	4000-724-4	4000-093	PC ASSEMBLY, PREAMPLIFIER
A4,A5,A6	4000-401	4000-088	HEATSINK ASSY POWER AMP.

TABLE 3-3

CIRCUIT BOARD LISTING 971XP

DESIGNATOR	ASSEMBLY NUMBER	SCHEMATIC	NAME
A1	4000-713-2	4000-088	PC ASSEMBLY, MOTHER BOARD
A2	4000-700-3	4000-081	PC ASSEMBLY, FILTER
A3	4000-724-3	4000-093	PC ASSEMBLY, PREAMPLIFIER
A4,A5	4000-401	4000-088	HEATSINK ASSY POWER AMP
A7	4000-400	4000-088	HEATSINK SUB-ASSEMBLY POWER AMP

TABLE 3-4

CIRCUIT BOARD LISTING 651XP

DESIGNATOR	ASSEMBLY NUMBER	SCHEMATIC	NAME
A1	4000-714-1	4000-088	PC ASSEMBLY, MOTHER BOARD
A2	4000-700-2	4000-081	PC ASSEMBLY, FILTER
A3	4000-724-2	4000-093	PC ASSEMBLY, PREAMPLIFIER
A4,A6	4000-401	4000-088	HEATSINK ASSY POWER AMP

TABLE 3-5

CIRCUIT BOARD LISTING 321XP

DESIGNATOR	ASSEMBLY NUMBER	SCHEMATIC	NAME
A1	4000-714-1	4000-088	PC ASSEMBLY, MOTHER BOARD
A2	4000-700-1	4000-081	PC ASSEMBLY, FILTER
A3	4000-724-1	4000-093	PC ASSEMBLY, PREAMPLIFIER
A7	4000-400	4000-088	HEATSINK SUB-ASSEMBLY POWER AMP

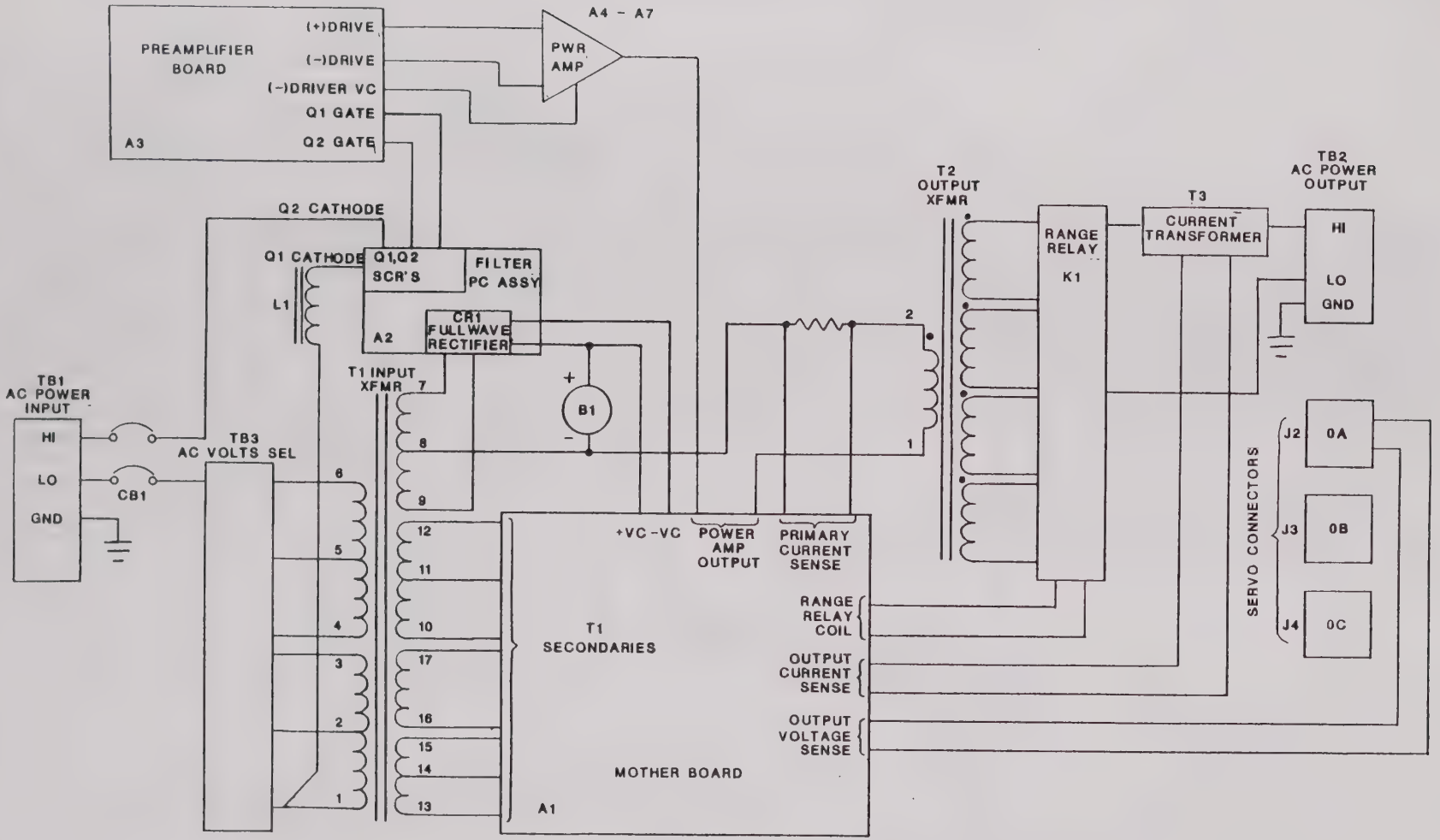


FIGURE 3.1

XP-SERIES POWER SOURCES BLOCK DIAGRAM

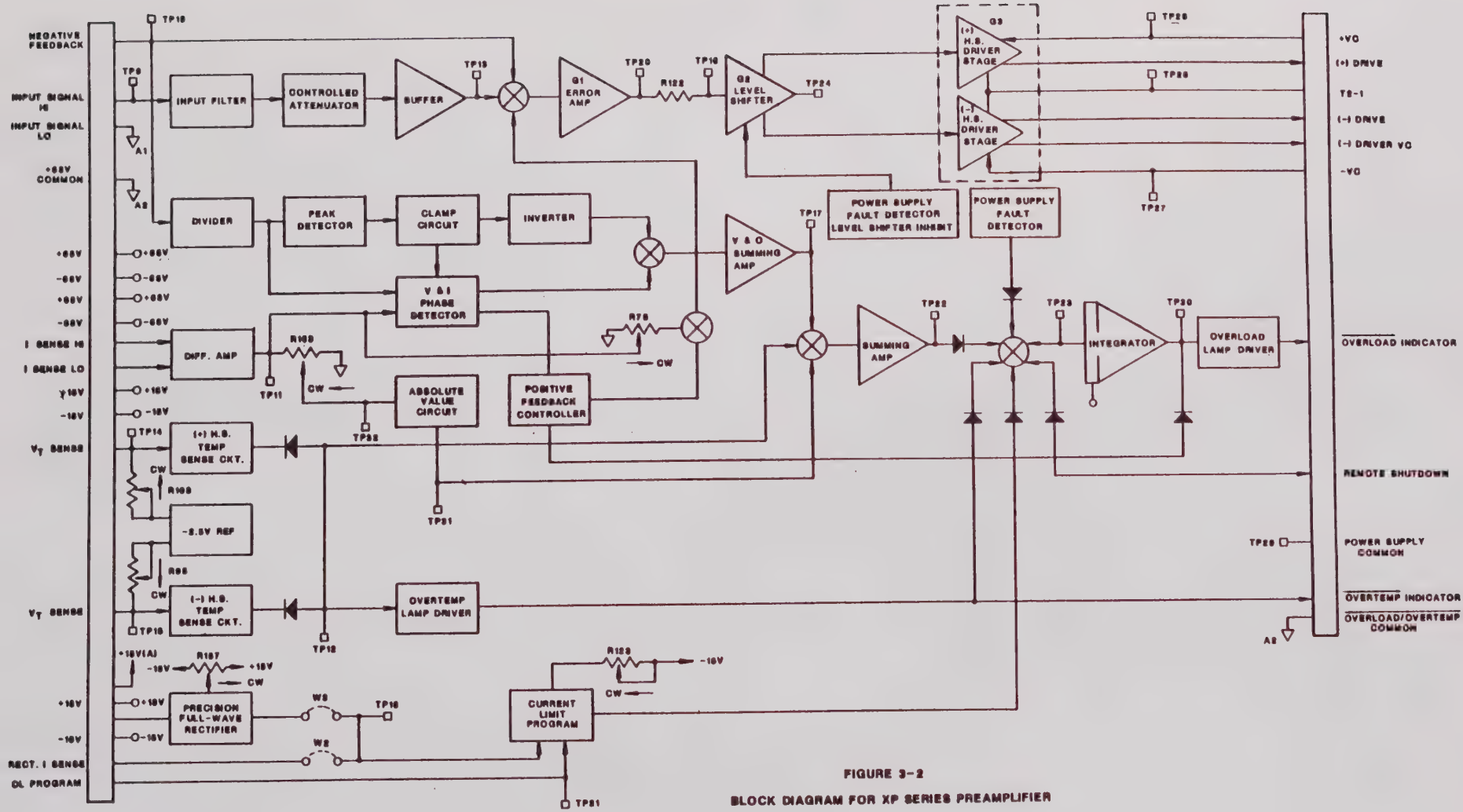


FIGURE 3-2

BLOCK DIAGRAM FOR XP SERIES PREAMPLIFIER

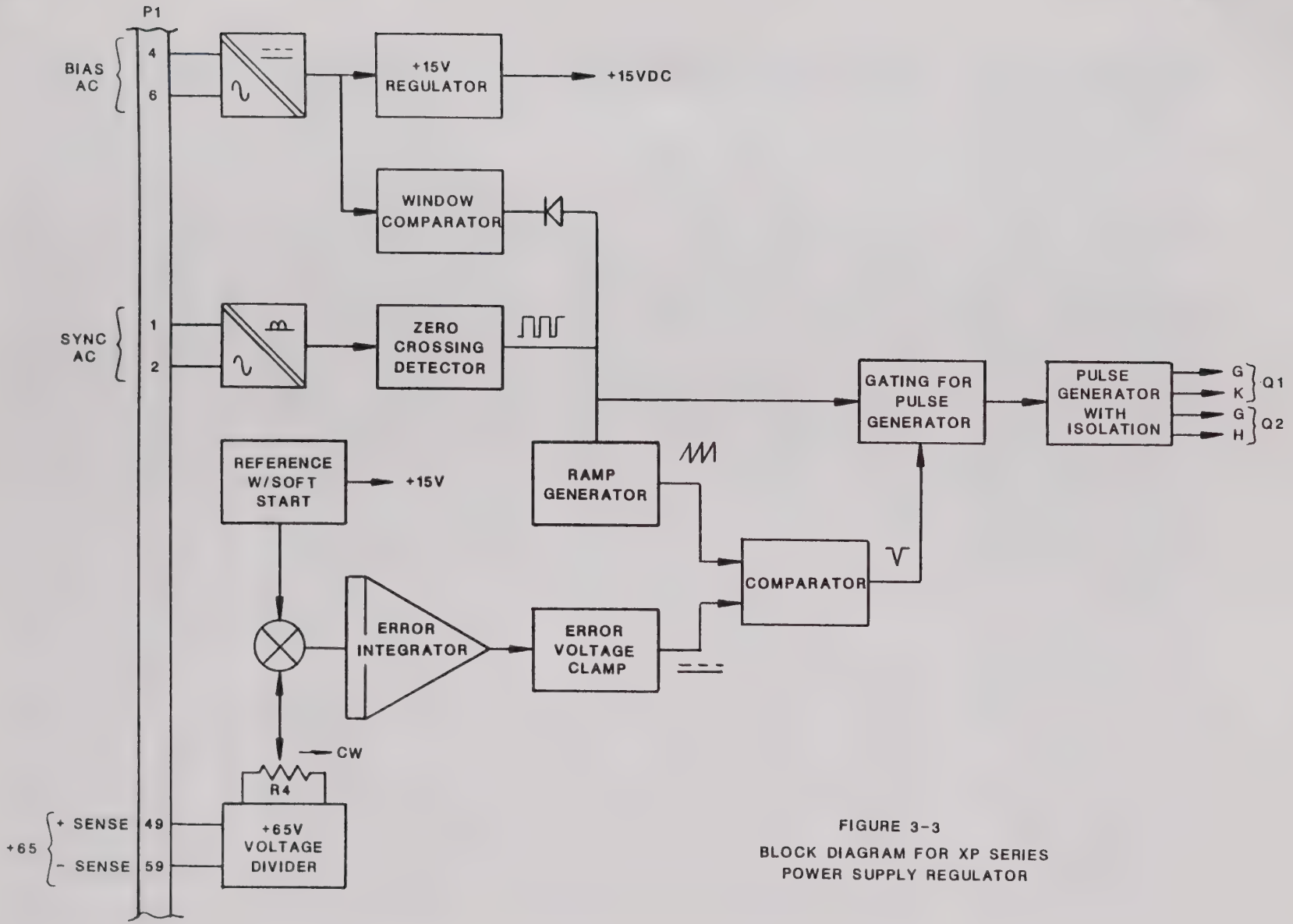


FIGURE 3-3

BLOCK DIAGRAM FOR XP SERIES POWER SUPPLY REGULATOR

3.2.5 Positive Voltage Feedback

The positive voltage feedback loop provides a signal proportional to the load current and is used to compensate for losses. Resistor, R1, in the current path of transformer, T2, senses the primary current and provides a voltage signal proportional to the primary current. This signal is amplified through A3U5 and is fed back in phase with the oscillator/power controller signal to the summing junction of the error amplifier , A3U16, of the preamplifier. The amount of positive feedback is adjusted with A3R75. The components A3R61, A3R60, A3C38, A3C40 and A3C42 provide high frequency compensation of the regulation circuit.

When the power source is driving power factor loads of <0.5 the positive feedback is attentuated to preserve output distortion and improve amplifier stability.

The attenuator consists of A3U13, part of A3U10 and transistor A3Q8 with associated components. Operation is as follows: the phase angle between the voltage and current is detected by exclusive ORing the outputs of A3U6. The output of the exclusive OR is averaged by A3C43 and the resulting signal is used to control current source, A3Q8. The current source, A3Q8, is used to control the resistance across terminals 4 and 6 of A3U13. This variable resistance is then used to shunt the positive feedback signal to the error amplifier, A3U16.

During startup or heavy overload conditions, transistor, A3Q7, is turned on which, in turn, causes maximum attenuation of the positive feedback.

3.2.6 Power Supply Fault Sensing

The $\pm$18 volt supplies in the unit are monitored by the programmable zener diode, A3VR10. The programmed set point is established by A3R39 and A3R40 such that the differential voltage between the two supplies must exceed 27 volts to enable the preamplifier via A3CR17, half of A3U17 and A3U11. Before the differential voltage is reached, A3VR10, is turned off, A3CR17 is forward-biased and the output of A3U17, pin 7, is low keeping A3U11 turned off. When the differential voltage is reached, A3CR17 is reversed-biased and the photofet, A3U11, is turned on. U11 has less than 300 ohms when it is fully on.

3.2.7 Current Limit Programming

Optional current limit programming is provided to allow the current limit set point to be programmed via the DC voltage from the associated oscillator/controller.

The circuit consisting of A3U18, one half of A3U14, A3CR47, A3CR48 and their associated components is used to full wave rectify the load current if the rectified signal is not available from the associated power monitor. Potentiometer, A3R157, is used to adjust for off-set voltages.

The programmed current limit DC voltage provided by the oscillator/power controller is proportional to the amount of allowable peak current at the output of the power source. This is summed through A3U8 with a small biasing voltage and the equivalent full-wave rectified signal of the output current. This rectified signal comes either directly from the associated Power Monitor or is generated on the preamplifier board. When the output current exceeds the programmed value, the integrator (A3U17) begins its limiting function and the overload lamp illuminates. Potentiometer, A3R123, is used to calibrate the threshold of the current limiting function.

3.2.8 Overload and Overpower Protection

Protection against conditions of overload, short circuit or negative power factors which could cause the power amplifier (G3) to fail due to exceeding the transistors SOA ratings is provided.

A3U6, A3U7, A3U10, A3U15, A3Q9, A3Q10 amd A3VR15 with associated components combine to generate a signal proportional to the voltage across the transistors in the power amplifier (G3). A3U7 with A3CR21, A3CR22, A3C41, A3R68 and A3R69 form a peak detector of the primary voltage. The output of the peak detector is sampled via A3Q9 and the output is averaged with low-pass filter, A3R92 and A3C47, to provide a signal proportional to phase angle. This signal is then summed with the inverted peak primary signal to produce an output at A3TP17 which is proportional to the power amplier Vce. This signal then becomes a variable threshold for detecting the maximum allowable peak current.

Primary current of the output transformer, T2, sensed by R1 located in the low side return path. The voltage developed across R1 is sensed via differential amplifier (one half of A3U5) and fed to the absolute value circuit (second half of A3U5).

One half of A3U17 is used as a summing amplifier for the power transistor Vce signal and the load current signal. The summing amplifier output then drives an integrator (second half of A3U17). The severity of the overload condition determines how negative the output of the integrator is driven and hence the level of attenuation of the oscillator input signal. As the oscillator signal is attenuated the OVERLOAD lamp on the front panel of the Power Monitor will become illuminated.

3.2.9 Temperature Sense Circuit

The heatsink temperatures of the power amplifier (G3) are sensed by solid state temperature sensors which provide a current output proportional to temperature. Generally, the cooler the heatsinks or transistors, the more power the transistors can safely deliver to the load.

The temperature sense circuit is comprised of A3U12, A3VR14 and associated components on the preamplifier assembly, in addition to the temperature sensors on the heatsinks. A3U12 is configured as a current-to-voltage converter with an offset current provided by A3VR14, A3R87, A3R95, A3R108 and A3R113. The outputs of A3U12 are OR'ed together and fed to the summing amplifier, A3U17. When the temperature of the heatsinks exceed the points where the transistors can no longer safely deliver rated output power, the ORing diodes, A3CR27 or A3CR28 will become forward biased lowering the threshold of the overload protection circuits.

If the airflow through the heatsinks was to become restricted or the ambient temperature was in excess of 55 degrees C, while under full load, the output of the temperature sense circuit would fall below the threshold of comparator, A3U8. When A3U8, pin 1, goes high, transistor, A3Q6, is forced on turning on the OVERTEMP lamp on the power monitor front panel.

At the same time that A3Q6 is on, the output of A3U8 is coupled into integrator, A3U17, via A3CR18 forcing the output of A3U17 negative and shutting off attenuator, A3U11.

3.2.10 Integrator

The integrator output controls the current through the LED of optocoupler, A3U11. A3U11, in conjunction with A3R79, forms a variable attenuator. By controlling the attenuator, the drive to the amplifier is controlled thus providing the means to protect the power amplifier (G3).

The non-inverting input of A3U17 (pin 5) is set at a reference provided by A3R142 and A3R143. This reference forces the output of A3U17 (pin 7) to be normally high turning attenuator, A3U11, fully on, providing maximum drive to the amplifier.

During OVERLOAD or OVERTEMP conditions, the integrator averages the signals from the summing amplifier, A3U17 (pin 1) or the temperature sense comparator, A3U8 (pin 1) to reduce the control current through the LED if A3U11, thus shutting off the oscillator signal to buffer amplifier, one half of A3U9.

3.2.11 Main Power Supply

A block diagram for the main DC power supply is shown in Figure 3-3. This power supply delivers $\pm$65 volts $\pm$3%. Each supply delivers 20 amperes DC for the 1301XP, 15 amperes DC for the 971XP, 10 amperes DC for the 651XP and 5 amperes DC for the 321XP with less than 4 volts peak-to-peak ripple from the 115/230V 60/50 Hz AC line. These regulated supplies consist of the following sections.

Bias AC is converted into raw DC voltage through A3CR4. The +15 volt regulator A3VR4 provides a +15 volt regulated supply for the power supply regulator circuitry.

A window comparator is used to sense the effective input voltage to the AC power source as provided by the raw DC input to A3VR4 and will inhibit the operation of the power supply regulator if the MAINS voltage is outside allowable limits. The window comparator is comprised of two sections of A3U1, A3VR5 and associated components. The outputs of the two sections of A3U1 are diode ORed together and when the MAINS voltage is out of limits, serves to inhibit the output of the zero crossing detector.

The zero crossing detector uses the sync AC signal to provide synchronization with the AC MAINS. The zero crossing detector is made up of A3CR5, one sector of A3U1 and associated components. Resistors A3R10 and A3R164 set the threshold for the zero crossing detector whose output is low whenever the sync AC signal is below the threshold. The negative going edge of the zero crossing detector output is used to reset the ramp circuitry and turn off the SCR firing circuitry.

The ramp circuitry consists of A3Q2, A3Q3, A3Q4, A3VR8, A3CR12, A3C21 and associated components. The ramp signal is enabled by the zero crossing detector output going high, turning off A3Q2 and this, in turn, causes A3Q3 to turn off. This action releases the clamp on A3C21 and allows the constant current source, A3Q4, A3VR8, A3CR12 to start charging A3C21.

The error amplifier, A3U2, is used to sense the +65 VDC supply and compare this to a reference to generate error voltage. This error voltage is then compared to the ramp voltage with one section of A3U1. As the ramp voltage on pin 10 of A3U1 exceeds the error voltage on pin 11 of A3U1, the output at pin 13 of A3U1 switches low generating a negative pulse into pin 6 of A3U3.

Dual timer, A3U3, is used to control and generate the triggering pulses for the back-to-back SCR's. One half of A3U3 is configured as a triggered one-shot and its output is then used to enable the second half of A3U3.

The second half of A3U3 is configured as an astable multivibrator operating at about 3 KHz with approximately a 5% duty cycle.

The output of A3U3, pin 9, is used to drive a current buffer, A3Q5. As A3Q5 is turned on, current flows through the LED in optoisolator, A3U4. The photon energy from the LED activates the output thyristor of A3U4 and the resulting current flow is steered via diodes, A3CR15 and A3CR16, to the forward biased SCR, thus triggering on the SCR.

3.2.12 Auxiliary Power Supply

A schematic diagram for the DC power supplies is part of drawing 4000-093. The auxiliary power supplies consist of a +18 VDC, +5 VDC, ±18 VDC, ±15 VDC and ±68 VDC.

The +8 VDC, ±18 VDC and ±68 VDC supplies are generated by rectifying an AC voltage derived from isolated secondaries of input transformer, T1. The rectified voltage is then filtered and provided for distribution to various assemblies within the power source.

The regulated auxiliaries, +5 VDC, ±15 VDC are derived from the +8 and ±18 VDC supplies, respectively. Regulation is performed by monolithic three-terminal regulators, A3VR1 for the +5 VDC output while ±15 supplies are regulated by A3VR2 and A3VR3.

The regulated supplies are used by the preamplifier and the power monitor. The raw auxiliaries are supplied to the associated plug-in oscillator.

WARNING

HIGH VOLTAGE (270 VAC)

Voltages up to 270 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with the primary power circuits, and the output circuits of the power source.

SECTION IV

CALIBRATION PROCEDURE

4.1 GENERAL

The following calibration and test procedures, or any part of them, may be performed on a routine basis to ensure that the XP Series Power Sources remain within specification tolerances. These procedures should always be performed after any repairs have been made to the unit. For your convenience, Table 4-1 lists the paragraph titles and page numbers for the calibration and test procedures.

Table 4-1 Calibration Procedure Listing

PARAGRAPH	PROCEDURE	PAGE
4.2	TEST EQUIPMENT REQUIRED	59
4.3	INITIAL ADJUSTMENTS	68
4.4	MEASURE POWER SUPPLY VOLTAGES	68
4.5	LOAD REGULATION ADJUSTMENT.	68
4.6	LINE REGULATION TEST.	69
4.7	HARMONIC DISTORTION TEST	70
4.8	FREQUENCY RESPONSE TEST	71
4.9	AC NOISE LEVEL TEST	71
4.9.1	Peak-to-Peak Measurements	71
4.9.2	RMS Measurements.	71
4.10	OVERLOAD PROTECTION	81
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4.10.2	Temperature Limit	81
4.11	0.7 LAGGING POWER FACTOR TEST	82
4.12	0.7 LEADING POWER FACTOR TEST	82
4.13	PROGRAMMABLE CURRENT LIMIT TEST	92
4.13.1	Test Current Limit.	92
4.14	24 HOUR AMPLITUDE STABILITY TEST.	95

This calibration procedure requires that the 321XP and 651XP power sources are tested using a 115 volt, 48 to 65 Hz AC line. The 971XP and 1301XP power sources are tested using a 230 volt, 48 to 65 Hz AC line. The XP sereies have a programmable range change built into their design. The standard range is 135 to 270 volts. The standard units can be altered to provide a 67.5 to 135 volt range by rearranging jumpers on the output transformer.

For operation from the 115 volt AC line, a 120 volt auto-transformer and a 120 volt wattmeter must be substituted for those called out in this procedure. Consult Section 2.2.1 of this instruction manual for operation from other than the 230 volt AC line.

This calibration procedure further assumes that the power source is tested at 25 ±3 degrees C ambient temperature on the 135 volt range. Performance is very similar on the 67.5 or 270 volt range. Tables 4-3-1 through 4-3-4 list output voltages, load settings and tolerances for the three voltage ranges for XP Series power sources. When checking load regulation and amplitude stability, care should be taken to use a four-wire connection such that the external load and the measurement equipment have completely separate wiring from the large AC output terminal strip, TB2, located at the rear of the power source.

TABLE 4-2

ADJUSTABLE COMPONENT LISTING

CIRCUIT DESIGNATOR	VALUE	DESCRIPTION
A3		Preamplifier/Power Supply Circuit Board
A3 R75	5K	Load Regulation Adjustment
A3 R4	5K	Power Supply Output Adjustment
A3 R123	50K	Programmable Current Limit Adjustment
A3 R157	100K	Offset Adjustment for Precision Rectifier Circuit
A3 R163	5K	Current Sense Voltage Signal Adjustment
A3 R95	1K	Negative Heatsink Temperature Sense Signal Adjustment
A3 R108	1K	Positive Heatsink Temperature Sense Signal Adjustment

NOTE: All resistors are in ohms

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the calibration procedure assuming that the input voltage has a nominal value of 230 volts rms and that the power source is tested on the 0 to 130 volt AC range.

a. Oscilloscope, Tektronix 2235 or equivalent.

b. 5 KVA autotransformer, Technipower 2XW50M or equivalent.

c. Power analyzer, Magtrol 4610 or equivalent.

d. Distortion analyzer, Hewlett Packard Model 339A or equivalent.

e. Multimeter, Keithley 192 Programmable DMM or equivalent.

f. Multirange load box Avtron Model K565D16766 or individual power resistors as defined in Tables 4-3-1 through 4-3-4 with proper power capability. Use Dale type NHL resistors or equivalent.

g. Current transformer Pearson Model 110 or equivalent.

h. Multimeter, Triplett Model 630NA or equivalent.

TABLE 4-3-1A

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES FOR 1301XP AT FULL RATED OUTPUT

100% OF RATED OUTPUT	67.5 VAC	135 VAC	270 VAC
Resistive load for 1671VA output	2.7 ohms	10.9 ohms	43.6 ohms
Resistive load for 1285VA output	3.5 ohms	14.2 ohms	56.7 ohms
Line Regulation ±0.1%	0.07 VAC	0.135 VAC	0.27 VAC
Load Regulation ±1%	0.7 VAC	1.35 VAC	2.7 VAC
AC Noise level			
-70dB rms shorted input	0.02V rms	0.043V rms	0.09V rms
-60dB P-P shorted input	0.19V P-P	0.382V P-P	0.764V P-P
-60dB rms at full power	0.07V rms	0.135V rms	0.27V rms
-50dB P-P at full power	0.6V P-P	1.21V P-P	2.42V P-P
Amplitude Stability (±0.25%)	0.17 VAC	0.34 VAC	0.67 VAC
Frequency Response ±0.5 dB	4 VAC	8 VAC	16 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-1B

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES
FOR 1301XP AT 78% RATED OUTPUT

78% of Rated Output	52.5 VAC	105 VAC	210 VAC
Resistive Load for 1300VA output	2.1 ohms	8.5 ohms	34 ohms
Resistive Load for 1000VA output	2.8 ohmss	11 ohms	44.1 ohms
Line Regulation (±0.1%)	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation (±1%)	0.525 VAC	1.05 VAC	2.1 VAC
AC Noise Level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.085V rms
-60dB P-P shorted input	0.191V P-P	0.382V P-P	0.764V P-P
-60dB rms at full power	0.067V rms	0.135V rms	0.27V rms
-50db P-P at full power	0.604V R-P	1.208V P-P	2.416 P-P
Amplitude Stability ±0.25%)	0.131 VAC	0.262 VAC	0.525 VAC
Frequency Response (±0.5dB	3.11 VAC	6.221 VAC	12/443 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-2A

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES FOR 971XP AT 100% RATED OUTPUT

100% OF RATED OUTPUT	67.5 VAC	135 VAC	270 VAC
Resistive load for 1253VA output	3.6 ohms	14.5 ohms	58.2 ohms
Resistive load for 964VA output	4.7 ohms	18.9 ohms	75.6 ohms
Line Regulation ±0.1%	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation ±1%	0.675 VAC	1.35 VAC	2.7 VAC
AC Noise level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.085V rms
-60dB P-P shorted input	0.191V P-P	0.382 P-P	0.764V P-P
-60dB rms at full power	0.067V rms	0.135V rms	0.27V rms
-50dB P-P at full power	0.604V P-P	1.208V P-P	2.416V P-P
Amplitude Stability (±0.25%)	0.168 VAC	0.317 VAC	0.675 VAC
Frequency Response ±0.5 dB	4 VAC	8 VAC	16 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-2B

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES
FOR 971XP AT 78% RATED OUTPUT

78% of Rated Output	52.5 VAC	105 VAC	210 VAC
Resistive Load for 975VA output	2.8 ohms	11.3 ohms	45.2 ohms
Resistive Load for 750VA output	3.7 ohms	14.7 ohms	58.8 ohms
Line Regulation (±0.1%)	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation (±1%)	0.525 VAC	1.05 VAC	2.1 VAC
AC Noise Level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.085V rms
-60dB P-P shorted input	0.191V P-P	0.382V P-P	0.764V P-P
-60dB rms at full power	0.067V rms	0.13V rms	0.27V rms
-50db P-P at full power	0.604V P-P	1.208V P-P	2.416V P-P
Amplitude Stability (0.25%)	0.131 VAC	0.262 VAC	0.525 VAC
Frequency Response ±0.5dB	3.11 VAC	6.221 VAC	12.443 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-3A

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES FOR 651XP AT 100% RATED OUTPUT

100% OF RATED OUTPUT	67.5 VAC	135 VAC	270 VAC
Resistive load for 835VA output	5.4 ohms	21.8 ohms	87.2 ohms
Resistive load for 643VA output	7.1 ohms	28.3 ohms	113.4 ohms
Line Regulation ±0.1%	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation ±1%	0.675 VAC	1.35 VAC	2.7 VAC
AC Noise level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.085V rms
-60dB P-P shorted input	0.191V P-P	0.382V P-P	0.8V P-P
-60dB rms at full power	0.067V rms	0.135V rms	0.27V rms
-50dB P-P at full power	0.604V P-P	1.207V P-P	2.416V P-P
Amplitude Stability (±0.25%)	0.168 VAC	0.337 VAC	0.675 VAC
Frequency Response ±0.5 dB	4 VAC	8 VAC	16 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-3B

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES
FOR 651XP AT 78% RATED OUTPUT

78% of Rated Output	52.5 VAC	105 VAC	210 VAC
Resistive Load for 650VA output	4.2 ohms	17 ohms	68 ohms
Resistive Load for 500VA output	5.4 ohms	22 ohms	88.2 ohms
Line Regulation (±0.1%)	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation (±1%)	0.525 VAC	1.05 VAC	2.1 VAC
AC Noise Level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.085V rms
-60dB P-P shorted input	0.191V P-P	0.382V P-P	0.764V P-P
-60dB rms at full power	0.07V rms	0.135V rms	0.27V rms
-50db P-P at full power	0.604V P-P	1.208V P-P	2.416V P-P
Amplitude Stability ±0.25%)	0.131 VAC	0.262 VAC	0.525 VAC
Frequency Response ±0.5dB	3.11 VAC	6.221 VAC	12.443 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-4A

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES FOR 321XP AT 100% RATED OUTPUT

100% OF RATED OUTPUT	67.5 VAC	135 VAC	270 VAC
Resistive load for 418VA output	10.9 ohms	43.6 ohms	174.5 ohms
Resistive load for 321VA output	14.2 ohms	56.7 ohms	226.8 ohms
Line Regulation ±0.1%	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation ±1%	0.7 VAC	1.35 VAC	2.7 VAC
AC Noise level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.085V rms
-60dB P-P shorted input	0.191V P-P	0.382V P-P	0.764V P-P
-60dB rms at full power	0.067V rms	0.135V rms	0.27V rms
-50dB P-P at full power	0.604V P-P	1.208V P-P	2.416V P-P
Amplitude Stability (±0.25%)	0.168 VAC	0.337 VAC	0.7 VAC
Frequency Response ±0.5 dB	4 VAC	8 VAC	16 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

TABLE 4-3-4B

CALIBRATION OUTPUT VOLTAGES, LOAD SETTINGS AND TOLERANCES
FOR 321XP AT 78% RATED OUTPUT

78% of Rated Output	52.5 VAC	105 VAC	210 VAC
Resistive Load for 325VA output	8.5 ohms	17 ohms	68 ohms
Resistive Load for 250VA output	11 ohms	22 ohms	88.2 ohms
Line Regulation (±0.1%)	0.067 VAC	0.135 VAC	0.27 VAC
Load Regulation (±1%)	0.525 VAC	1.05 VAC	2.1 VAC
AC Noise Level			
-70dB rms shorted input	0.021V rms	0.043V rms	0.09V rms
-60dB P-P shorted input	0.191V P-P	0.382V P-P	0.764V P-P
-60dB rms at full power	0.067V rms	0.135V rms	0.27V rms
-50db P-P at full power	0.604V P-P	1.208V P-P	2.416V P-P
Amplitude Stability (±0.25%)	0.13 VAC	0.262 VAC	0.525 VAC
Frequency Response (±0.5dB)	3.11 VAC	6.221 VAC	12.443 VAC

CAUTION

All loads should be sized to safely dissipate the rated output of the power source being tested, and exhibit a power factor of not less than 0.98 over the frequency range of 45 Hz to 10 KHz.

4.3 INITIAL ADJUSTMENTS

Check input power level:

1. Connect the XP Series Power Source input as shown in Figure 4-2 and power output as shown in Figure 4-3.

2. Turn the AMPLITUDE control of the oscillator fully counterclockwise.

3. Adjust the autotransformer for nominal input voltage to 115 VAC for the 321XP and the 651XP or 230 VAC for the 971XP and the 1301XP

4. Turn circuit breaker "ON". The wattmeter should indicate equal to or less than 160 watts.

4.4 MEASURE POWER SUPPLY VOLTAGES

Measure the DC power supply voltages at test points, TP12 through TP23, of the preamplifier assembly, A3. These voltages and tolerances are listed in Table 4-4.

4.5 LOAD REGULATION ADJUSTMENT

NOTE

> Care should be taken to ensure that the output amplitude of the oscillator reamins stable and independent of line and load conditions during this test.

The following steps are used to minimize the output impedance of the power source.

If not already accomplished, connect the power source and test equipment per Figure 4-2 and 4-3.

1. Set the autotransformer to nominal input voltage of 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.

2. Turn power source "ON".

3. Set the frequency to 400 Hz.

4. Adjust output voltage to 105 VAC.

5. Apply 100% load for 78% output voltage. Reference Tables 4-3-1 through 4-3-4.

6. Adjust A3R75, regulation control, for 105 VAC $\pm$10mV.

7. Remove the load.

8. Repeat steps 4 through 7 until the difference between the full load and no load voltage is less than 100 mVAC.

9. Set the output frequency to 45 Hz and readjust the output for 105 VAC. Apply full load and verify that the output change does not exceed ±1.05 VAC.

10. Remove the load.

11. Repeat steps 9 and 10 at a frequency of 5 KHz. NOTE: If the preamplifier board or the output transformer has been replace, then capacitor, A3C70, may have to be selected to bring the regulation at 5 KHz within ±1%. When adjusting A3C70, use the minimum capacitance to meet the 1% regulation requirement.

12. Additional load regulation checks may be performed at any frequency within the range of the unit.

4.6 LINE REGULATION TEST

The following steps may be used for testing response to changes in AC input line voltage.

If not already accomplished, connect the power source and test equipment per Figure 4-3.

NOTE

Care should be taken to ensure that the output amplitude of the oscillator remains stable and independent of line and load conditions during this test when using other than a California Instruments plug-in oscillator/power controller.

1. Set the autotransformer to 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.

2. Turn unit "ON" and adjust output voltage to 135 VAC.

3. Set the frequency to 400 Hz.

4. Apply 100% load for 100% output. (Readjust output voltage for 135 VAC, if necessary.) Reference Tables 4-3-1 through 4-3-4.

5. Vary the line input voltage from 103 to 127 VAC for low input range and from 207 to 253 VAC for high input range. Measure the change in the output voltage of the amplifier. This change should be less than ±.135 VAC.

6. Remove the load.

7. Repeat steps 1 through 5 at 45 Hz and 5 KHz. The output should change less than ±.135 VAC over the entire frequency range.

4.7 HARMONIC DISTORTION TEST

The following steps may be taken for testing the harmonic distortion of the power source.

If not already accomplished, connect the power source and test equipment per Figure 4-3.

NOTE

If an external oscillator is used for this test, the distortion of the signal must be less than 0.1% THD.

1. Set the autotransformer to 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.
2. Turn the unit "ON".
3. Set the frequency to 400 Hz.
4. Set the output to 105 VAC. Verify distortion is less than 0.5%.
5. Apply 100% load for 78% output. Reference Tables 4-3-1 through 4-3-4.
6. Vary the line voltage from 103 to 135 VAC for the 321XP and 651XP or 207 to 253 VAC for the 971XP and 1301XP. Verify that distortion is less than 0.5%. Return the line voltage to nominal input, either 115 VAC or 230 VAC.
7. Remove the load and repeat step 6.
8. Adjust the output for 135 VAC. Verify distortion is less than 0.5%.
9. Apply 100% load for 100% output. Reference Tables 4-3-1 through 4-3-4.
10. Repeat steps 6 and 7.
11. Repeat steps 3 through 10 for 45 Hz and 5 KHz.
12. These tests may be performed at any frequency within the limits of the power source.

4.8 FREQUENCY RESPONSE TEST

The following steps are used to establish the frequency response of the power source over its operating frequency range.

If not already accomplished, connect power source and test circuits per Figure 4-2 and 4-3.

1. Adjust input line voltage to 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP. Set oscillator frequency to 400 Hz.

2. Turn unit "ON" and adjust AMPLITUDE control for 135 VAC.

3. Vary the output frequency of the oscillator from 45 Hz to 5 KHz and monitor the output voltage of the power source with the DMM under no-load condition. The output of the power source should vary less than 7.55 volts rms from 45 Hz to 5 KHz.

4. Apply 100% load for 100% rated output. Again vary the frequency from 45 Hz to 5 KHz. The output voltage should vary less than 7.55 volts rms.

5. Remove the load.

4.9 AC NOISE LEVEL TEST

4.9.1 Peak-to-Peak Measurements

If not already accomplished, connect the power source and test circuits per Figure 4-2 and 4-3.

1. Adjust the autotransformer for 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.

2. Turn unit "OFF".

3. Remove the plug-in oscillator or disconnect the external oscillator.

4. Short A3TP2 to A3TP12 and A3TP12 to the anode of A3CR36 with a short jumper (less than 6 inches).

5. Turn unit "ON".

6. With the oscilloscope, measure the peak-to-peak voltage. Verify that this voltage is more than 60 dB below full output.

7. Turn the unit "OFF".

8. Remove the shorts between A3TP12 to A3TP2 and A3TP12 to the anode of A3CR36.

9. Insert the plug-in oscillator or reconnect the external signal source.

10. Set the frequency to 400 Hz.

11. Turn unit "ON".

12. Adjust the output for 105 VAC.

13. Apply 100% load for 78% output.

14. Using the offset feature of the 7A18A plug-in, measure the peak-to-peak noise. Verify that noise is 50 dB below full output. Reference Tables 4-3-1 through 4-3-4.

4.9.2 RMS Measurements

1. Follow steps 4.9.1 step 1 through 5.

2. With the DMM measure the rms voltage.

3. Verify that this voltage is more than 70 dB below full output.

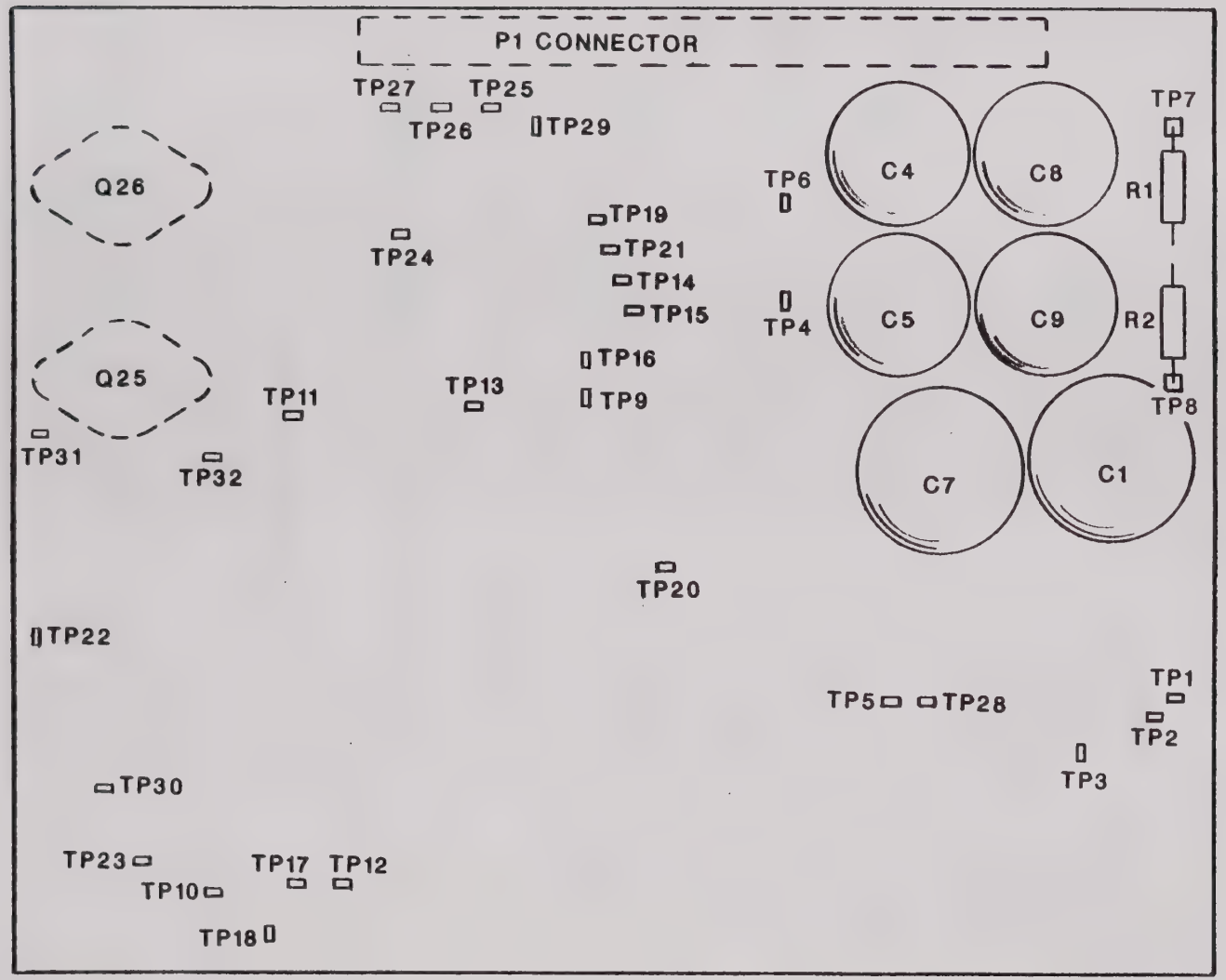


FIGURE 4-1

XP SERIES DC POWER SUPPLY
PREAMP TEST POINTS

Table 4-4
DC Power Supply/Preamplifier Test Points

TEST POINT #	TEST POINT DEFINITION	VALUE AT TEST POINT
TP1	+8 VDC Supply	+8 VDC +3V/-0.5V
TP2	+5 VDC Supply	+5 VDC ±0.2V
TP3	+18 VDC Supply	+18 VDC +3V/-0.5V
TP4	+15 VDC Supply	+15 VDC ±0.75V
TP5	-15 VDC Supply	-15 VDC ±0.75V
TP6	-18 VDC Supply	-18 VDC +3V/-0.5V
TP7	+68 VDC Supply	+68 VDC +6V/-2V
TP8	-68 VDC Supply	-68 VDC +2V/-6V
TP9	Oscillator Input	5 volts rms (typical) for Full Scale Output Voltage
TP10	-18 VDC on the preamplifier section of A3 board	-18 VDC +3V/-0.5V
TP11	Output of differential amplifier equivalent to amplified current sense signal	10V ±2% at 100% load for 25 degrees C ambient, 7.67V peak ±2% at 100% load for 55 degrees C ambient

TABLE 4-4 (CONT.)

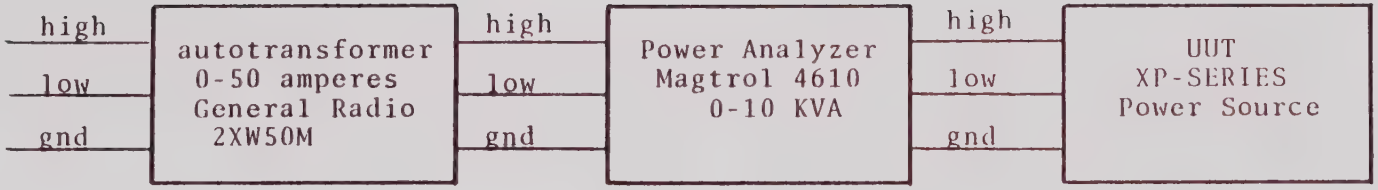
TEST POINT #	TEST POINT DEFINITION	VALUE AT TEST POINT
TP12	Output of Temperature Sense Circuit	6.42 VDC ±0.19V max. at full rated output at TA=25 degrees C 0V at full rated output at TA=55 degrees C (It depends on amount of load and heatsinks power dissipation)
TP13	Output of buffer Amplifier (U9)	5 volts rms (typical) for full scale output voltage
TP14	+Heatsink Temperature Sense Voltage	~0 VDC (Virtual Ground)
TP15	-Heatsink Temperature Sense Voltage	0 VDC (Virtual Ground)
TP16	Level Shifter Error Signal	0 VDC
TP17	Signal equivalent to output transistor Vce	8.42V DC ±2% max from 100% to 78% of rated output and unity to 0.7 power factor.
TP18	Signal equivalent to the output current	1.14V peak max ±6mV Full-wave rectified at full rated output current.
TP19	Negative Feedback	Approximately 39.7V rms at 100% of rated output and full load at 400 Hz.
TP20	Output of error amplifier (U16)	Sine wave signal

TABLE 4-4 (cont.)

TEST POINT #	TEST POINT DEFINITION	VALUE AT TEST POINT
TP21	Current limit programming voltage	9.765 VDC ±1% for 100 Amps current
TP22	Output of summing amplifier (U17, pin 1)	Full-wave rectified signal (The peak value depends on the amount of limiting.)
TP23	Input to the integrator, (U17, pin 7)	The value depends on degree of limiting ≥3.225V
TP24	Level shifter sense feedback	0 VDC ±.5V
TP25	+65 VDC supply	+65 VDC ±0.2V
TP26	Output Transformer Primary	Approximately 39.7V rms at 100% of rated output and full load at 400 Hz.
TP27	-65 VDC Supply	-65 VDC ±0.2V
TP28	±66V Return	0 volts
TP29	Power Supply Common	0 volts
TP30	Output of Integrator (U17)	+13 VDC ±5% under normal mode of operation. It becomes less positive under overload conditions.

TABLE 4-4 (cont.)

TEST POINT #	TEST POINT DEFINITION	VALUE AT TEST POINT
TP31	Current Sense Voltage Signal (Output of Rectifier)	Full wave rectified signal with 5V ±1% peak at TA=25 degrees C. 3.835V ±1% peak at TA=55 degrees C.
TP32	Amplified Current Sense Voltage Signal at wiper of its adjustment potentiometer	Adjusted for 10V peak or 7.07V rms at 100% load for 100% output at maximum frequency.



See Table 2-1 for AC line input wiring to the XP-Series Power Source. Unit is normally wired for 115 ±10 volts for 321XP and 651XP or 230 ±20 volts for 971XP and 1301XP AC line operation.

FIGURE 4-2. XP-Series AC Input Power Connection Diagram

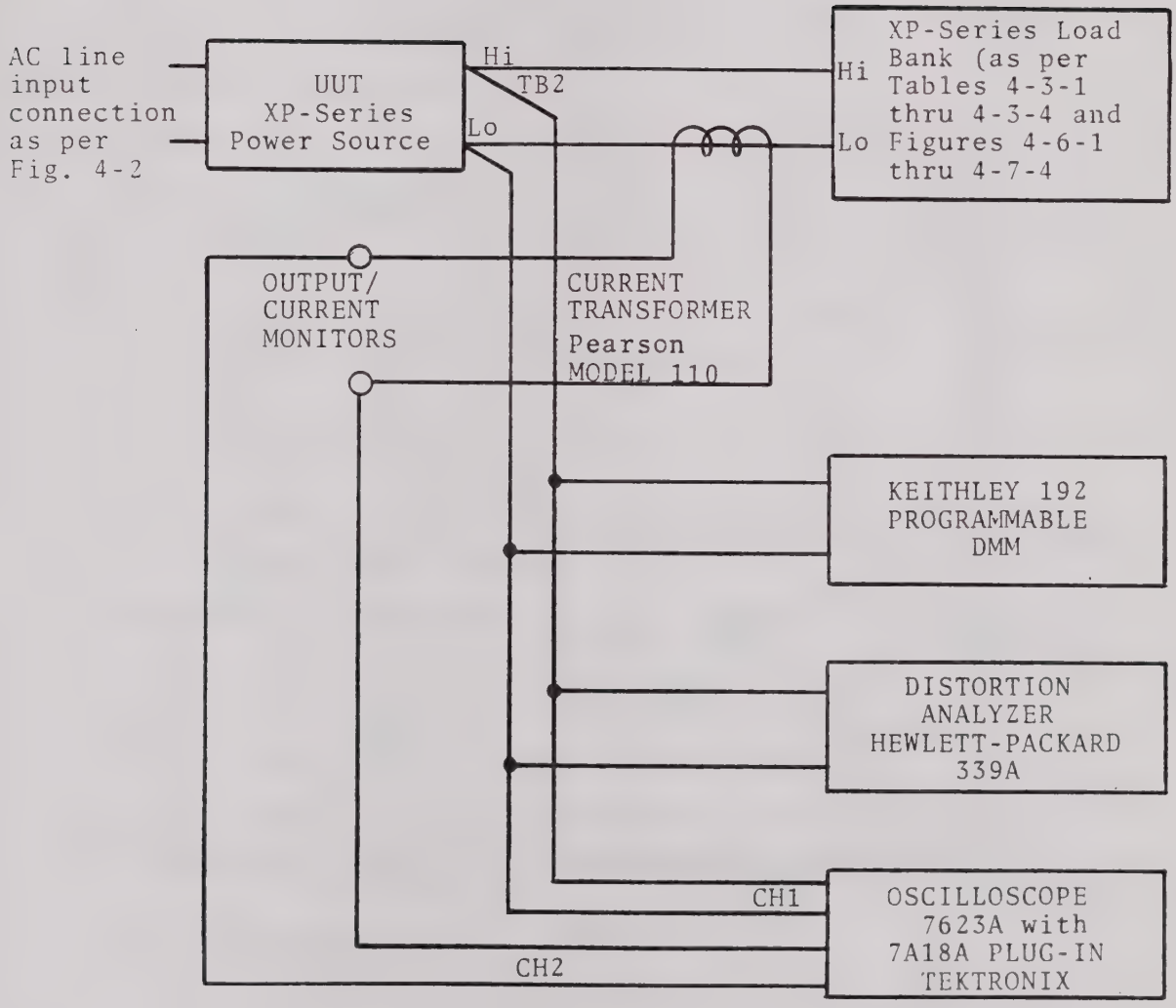


FIGURE 4-3. XP-SERIES TEST CIRCUIT CONNECTION DIAGRAM

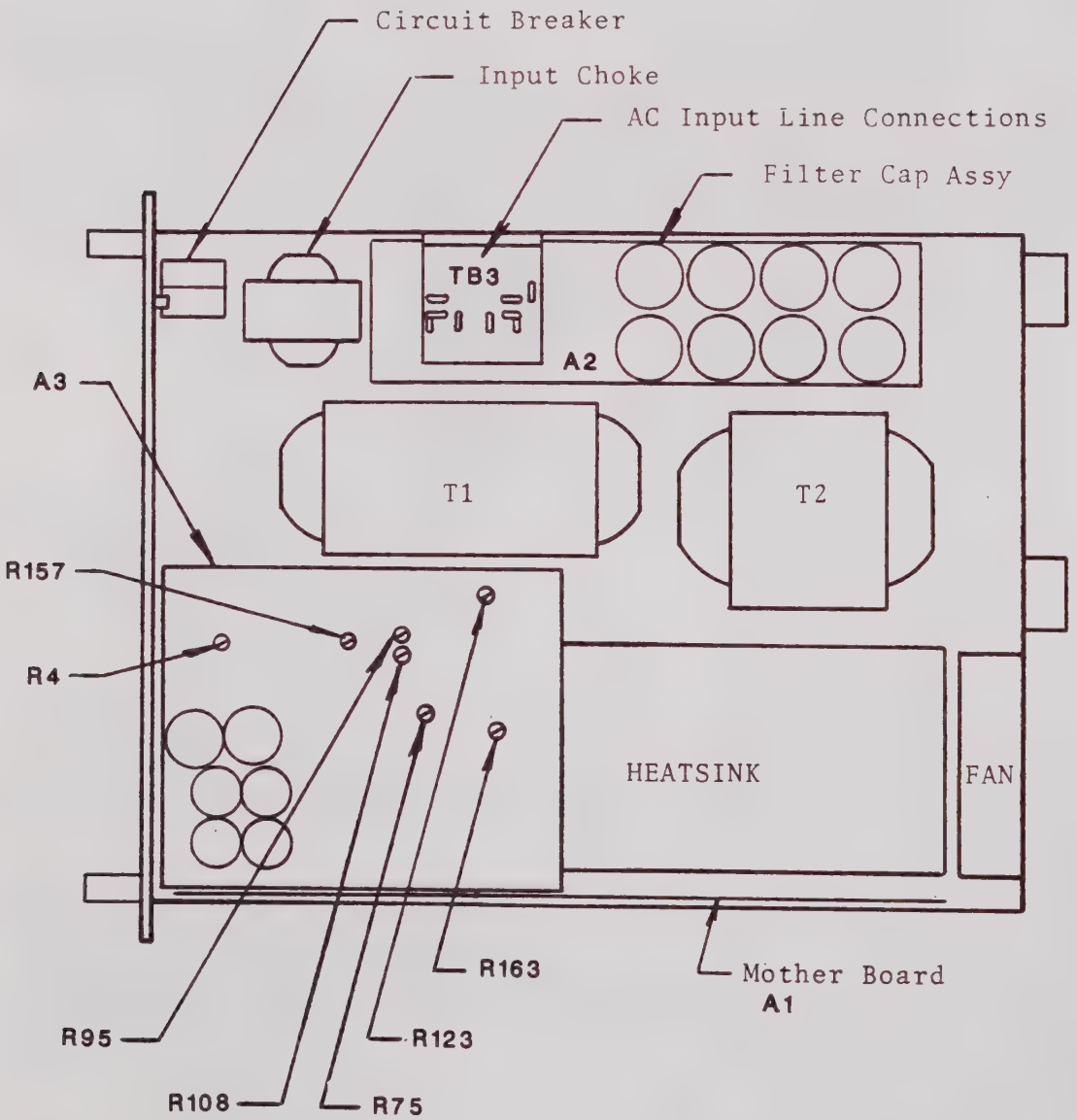


FIGURE 4-4
LOCATION OF INTERNAL ADJUSTMENTS FOR XP-SERIES POWER SOURCE

4.10 OVERLOAD PROTECTION

The following tests are used to check operation of the protection circuits.

If not already accomplished, connect the power source and test equipment as per Figure 4-2 and 4-3.

4.10.1 Current Limit

1. Adjust the autotransformer for 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.
2. Turn unit "ON" and adjust AMPLITUDE control for 135 VAC output.
3. Set the frequency to 5 KHz.
4. Apply 100% load for 100% rated output.
5. Measure the AC voltage, A3TP6. Verify that this is 7.07 ±.025 VAC. Adjust A3R163, if required.
6. Adjust the AMPLITUDE control for 105 VAC output.
7. Apply 100% load for 78% output.
8. While monitoring the oscilloscope, slowly increase the output using the AMPLITUDE control and observe that the output will begin to clip at the peaks. Back off the output unitl the clipping just disappears.
9. Apply a short circuit across the load.
10. Observe that the front panel OVERLOAD lamp is on.
11. Remove the short and observe that the output ramps back up into 100% load.

4.10.2 Temperature Limit

1. Set the unit as in 4.10.1, steps 1 through 4.
2. Monitor the cathodes of A3CR15 and A3CR16 with the oscilloscope.
3. With a piece of cardboard, block the air flow from the fan at the rear of the unit.
4. Observe that the voltage on the oscilloscope begins to decrease.

5. Maintain the air blockage and observe that as the voltage becomes less positive and that the green LED, A3DS1, is beginning to extinguish and that the front panel OVERLOAD lamp is lighted.

6. Maintain the air blockage and observe that the voltage goes negative and that the front panel OVERTEMP lamp lights and that the output goes to zero.

7. Remove the air blockage and observe that after a few minutes the output recovers to that in step 1.

4.11 0.7 LAGGING POWER FACTOR TEST

The following steps are used to verify the ability of the power source to drive a 0.7 lagging power factor load. This represents the worst case inductive load for maximum power dissipation inside the power source. Select the proper load and temperature values for the power source from Figures 4-5A through 4-8B.

If not already accomplished, connect power source and test circuits per Figure 4-4.

1. Adjust the autotransformer for 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.

2. Turn unit "ON" and adjust AMPLITUDE control for 105 VAC output.

3. Apply proper load to the output (0.7 lagging power factor at 78% rated output). Check that the power source maintains a stable output, with no high frequency oscillation. Verify distortion is less than 0.5%.

4. Remove the load.

4.12 0.7 LEADING POWER FACTOR TEST

The following steps are used to verify the ability of the power source to drive a 0.7 leading power factor load. This represents the worst case load for maximum power dissipation inside the power source. Select the proper loads and temperature values for the power source from Figures 4-9A through 4-12B.

If not already accomplished, connect the power source and test circuits per Figure 4-4.

1. Adjust the autotransformer for 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP. Set the oscillator to 400 Hz.

2. Turn unit "ON" and adjust the AMPLITUDE control for 105 VAC output.

3. Apply proper load to the output (0.7 leading power factor at 78% rated output). Check that the power source maintains a stable output with no high frequency oscillation. Verify that distortion is less than 0.5%.

4. Remove the load.

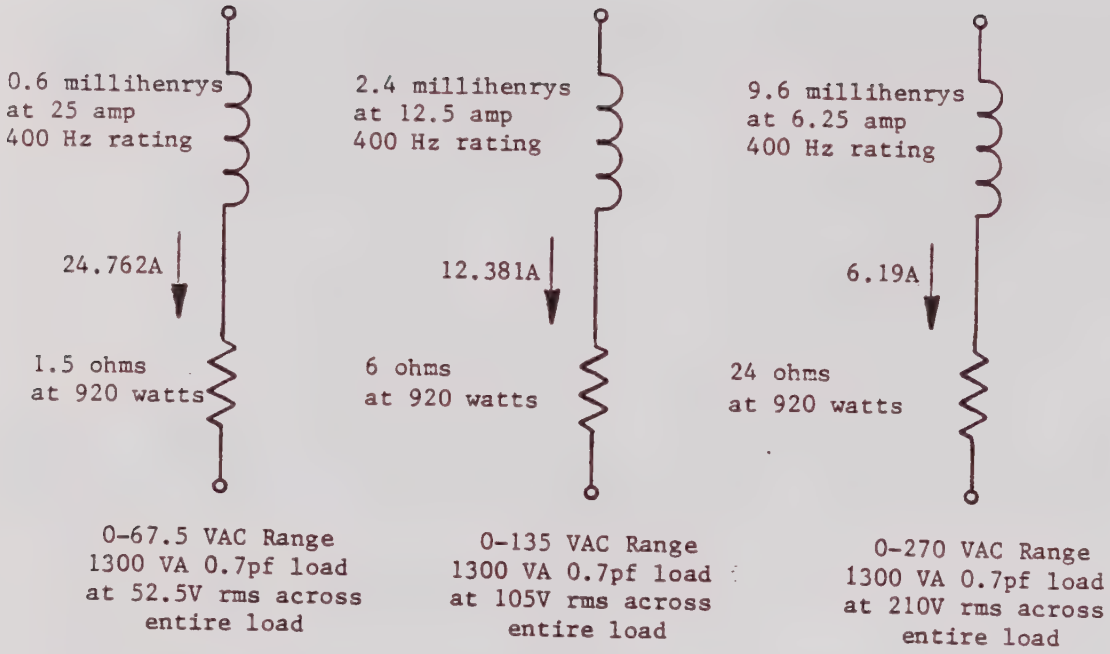


FIGURE 4.5A. Load Circuit for TA=25°C 0.7 Lagging Power Factor at 400 Hz.

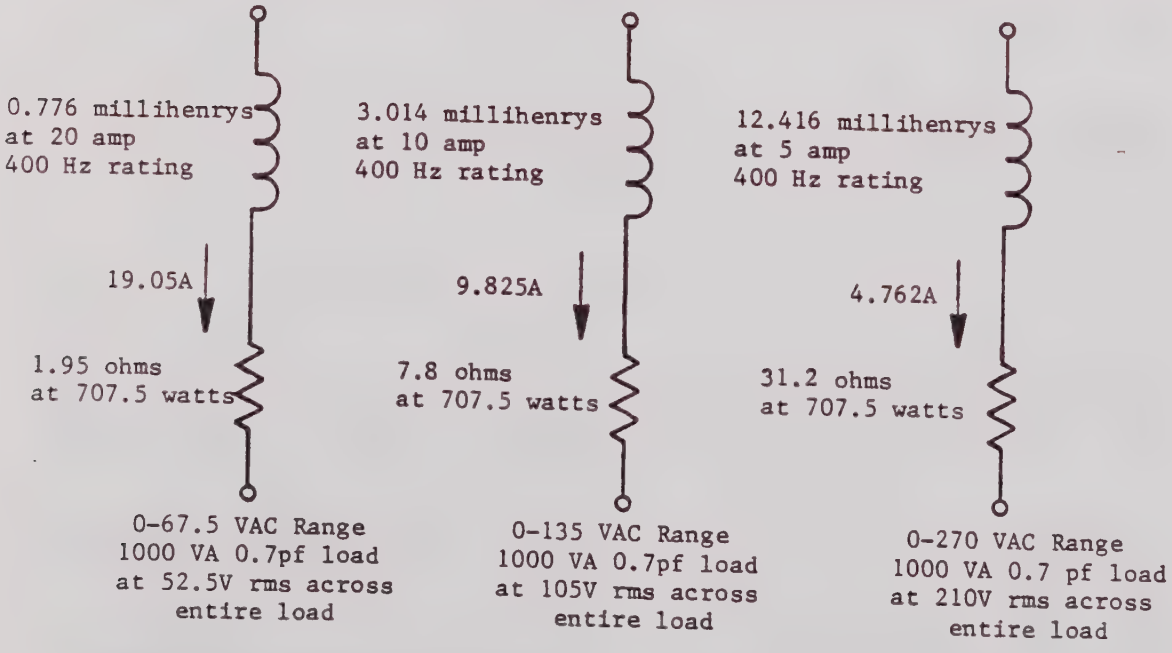


FIGURE 4.5B. Load Circuit for TA=55°C 0.7 Lagging Power Factor at 400 Hz.

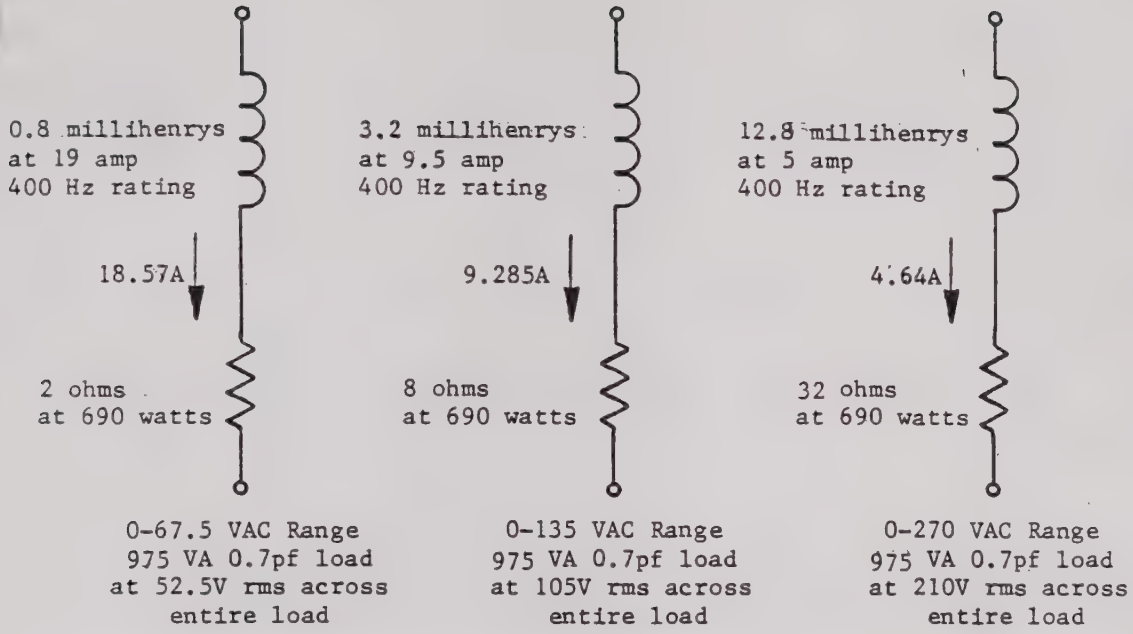


FIGURE 4.6A. Load Circuit for TA=25°C 0.7 Lagging Power Factor at 400 Hz.

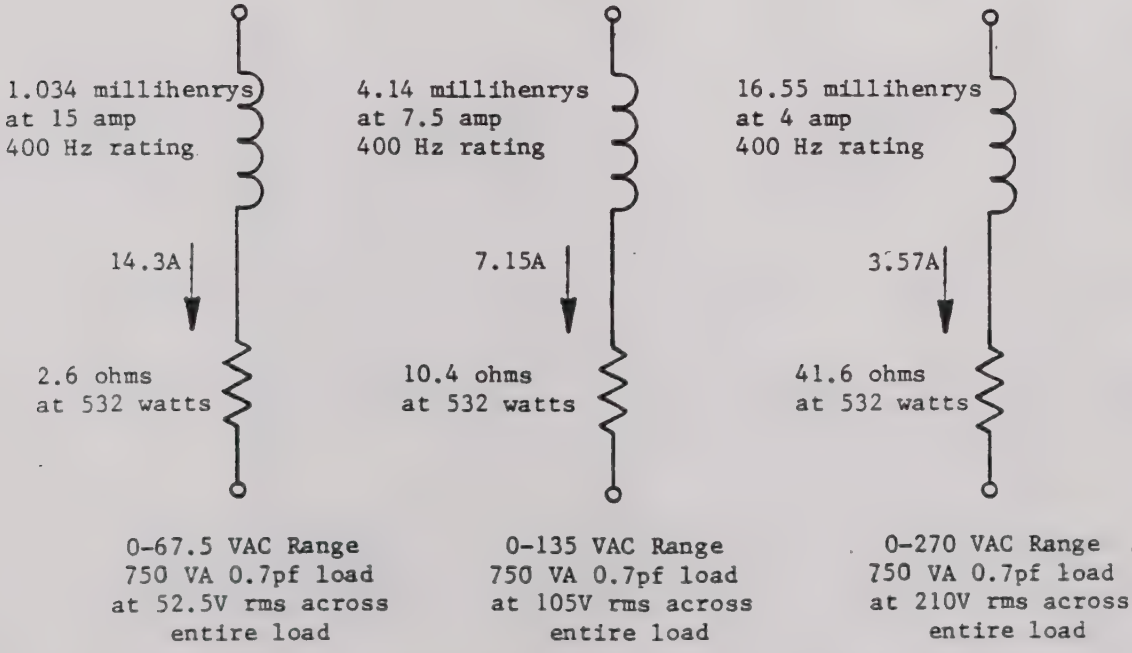


FIGURE 4.6B Load Circuit for TA=55°C 0.7 Lagging Power Factor at 400 Hz.

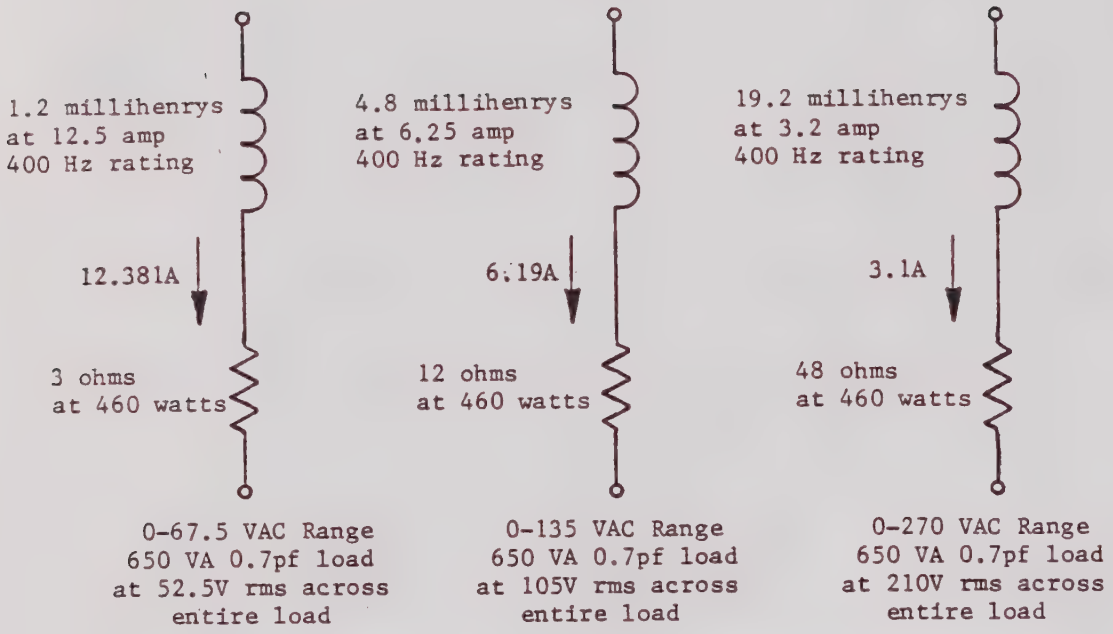


FIGURE 4.7A. Load Circuit for TA=25°C 0.7 Lagging Power Factor at 400 Hz.

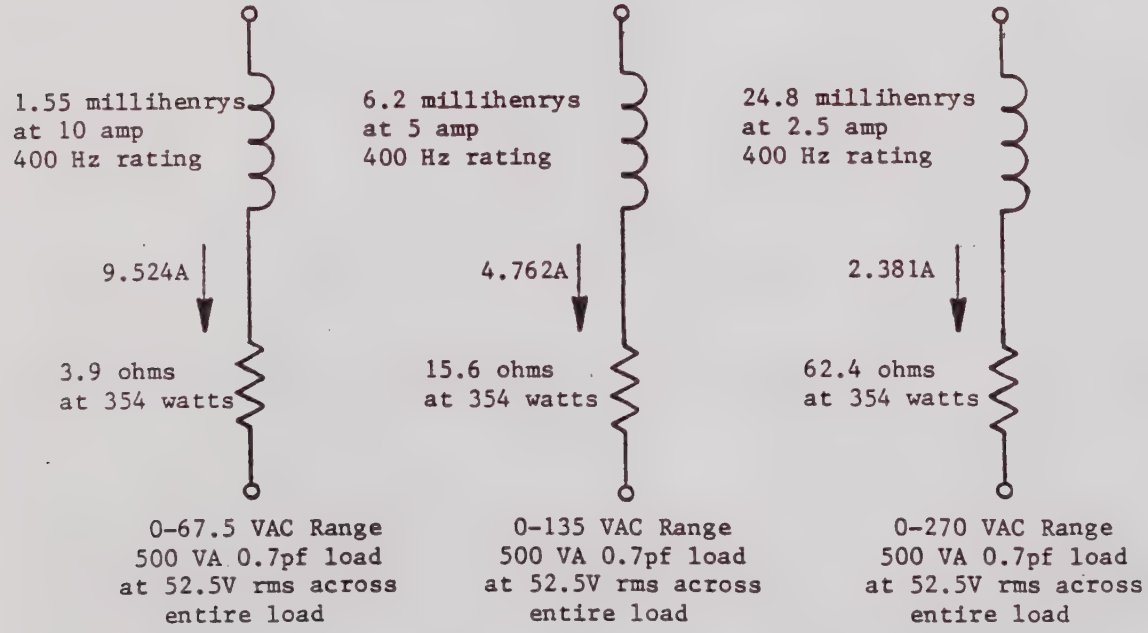


FIGURE 4.7B. Load Circuit for TA=55°C 0.7 Lagging Power Factor at 400 Hz.

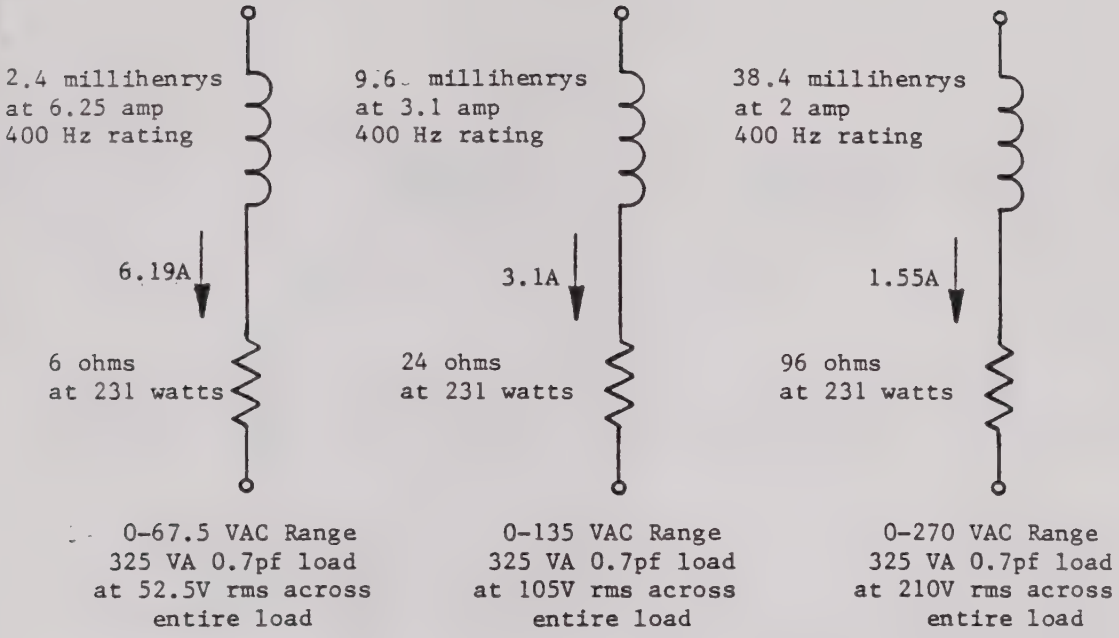


FIGURE 4.8A. Load Circuit for TA=25°C 0.7 Lagging Power Factor at 400 Hz.

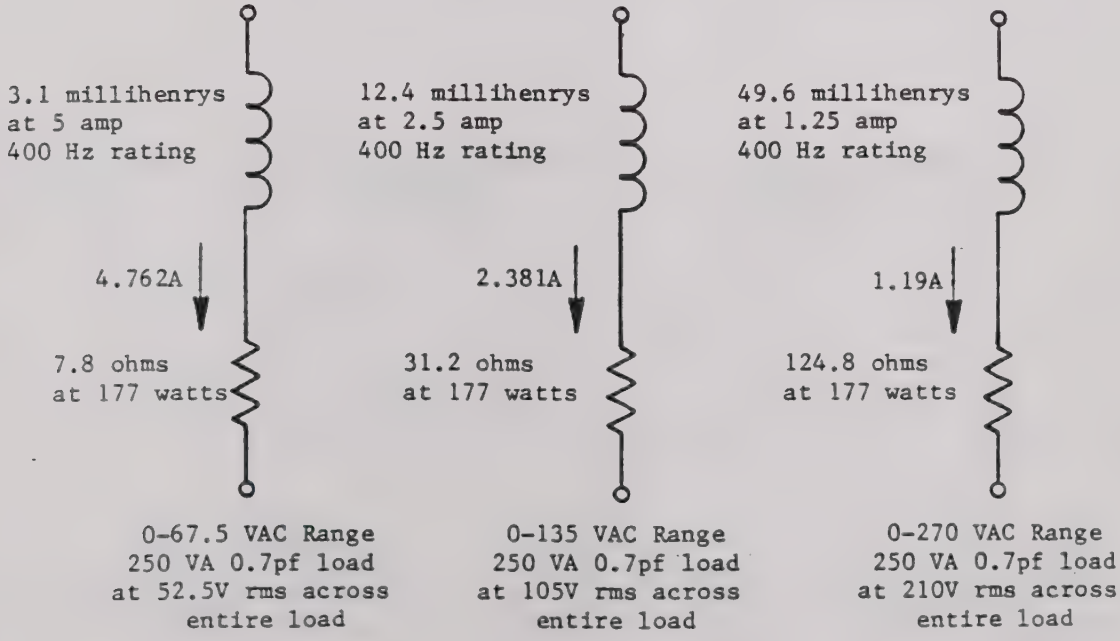


FIGURE 4.8B Load Circuit for TA=55°C 0.7 Lagging Power Factor at 400 Hz.

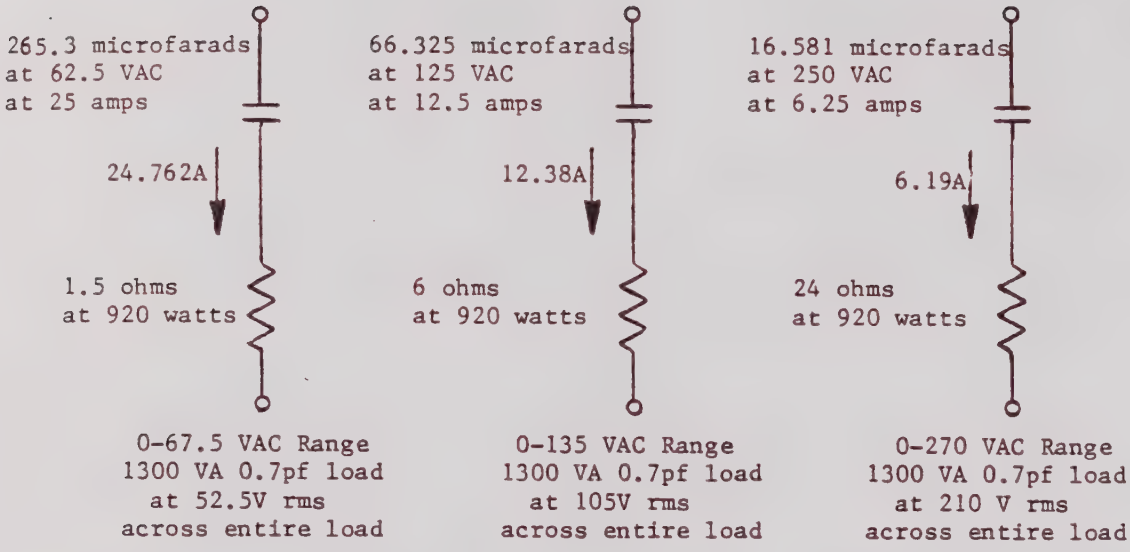


FIGURE 4.9A. Load Circuit for TA=25°C 0.7 Leading Power Factor at 400 Hz.

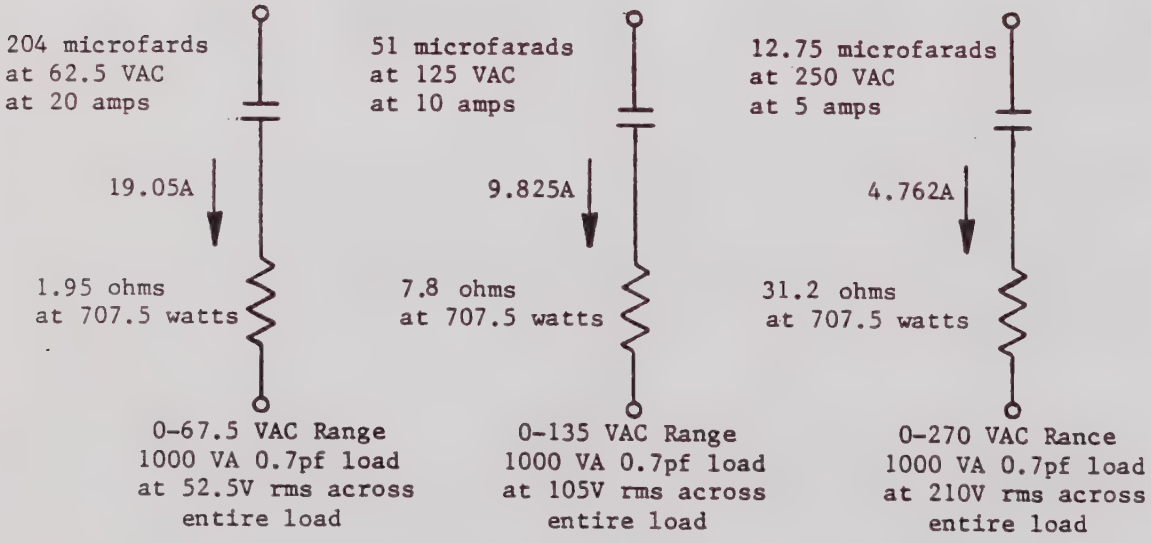


FIGURE 4.9B. Load Circuit for TA=55°C 0.7 Leading Power Factor at 400 Hz.

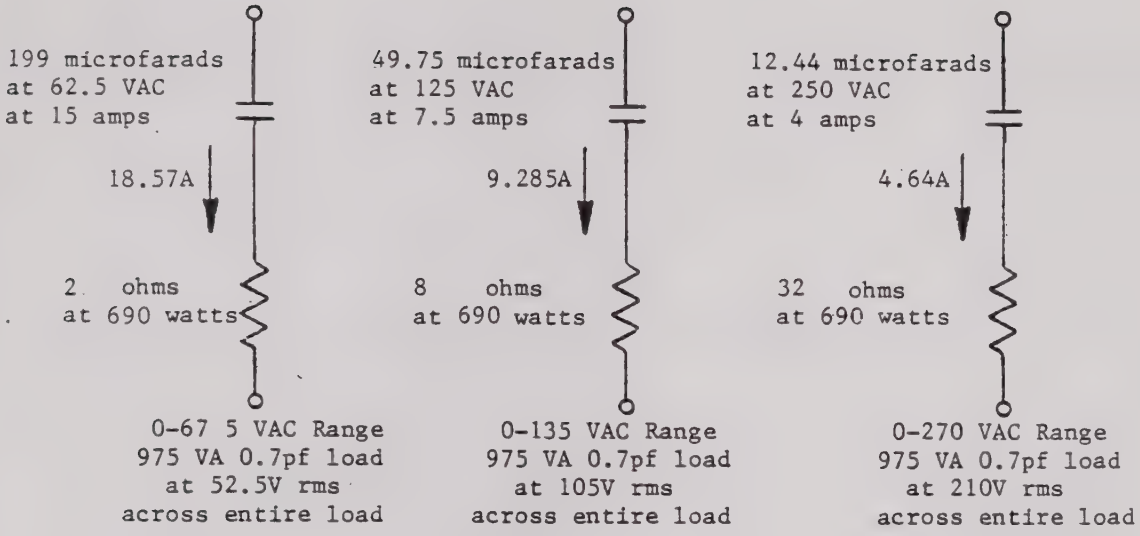


FIGURE 4-10A. Load Circuit for TA=25°C 0.7 Leading Power Factor at 400 Hz.

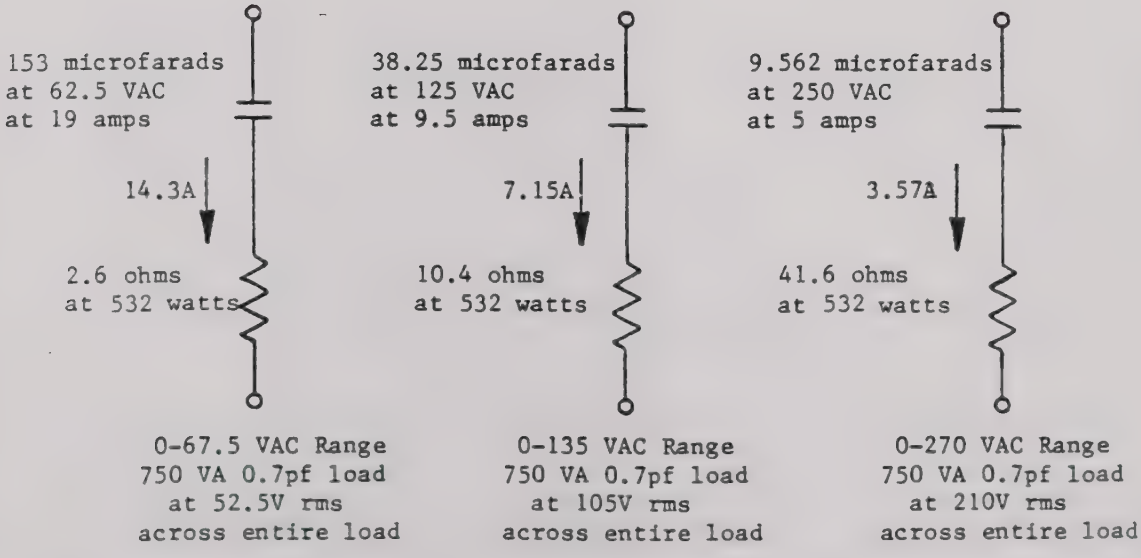


FIGURE 4.10B. Load Circuit for TA=55°C 0.7 Leading Power Factor at 400 Hz.

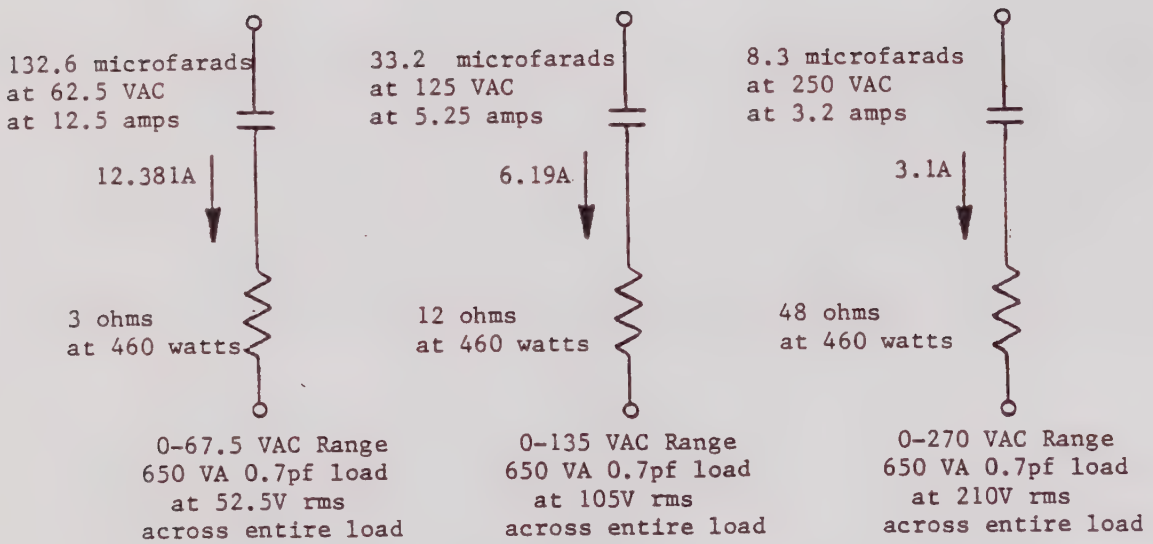


FIGURE 4.11A. Load Circuit for TA-25°C 0.7 Leading Power Factor at 400 Hz.

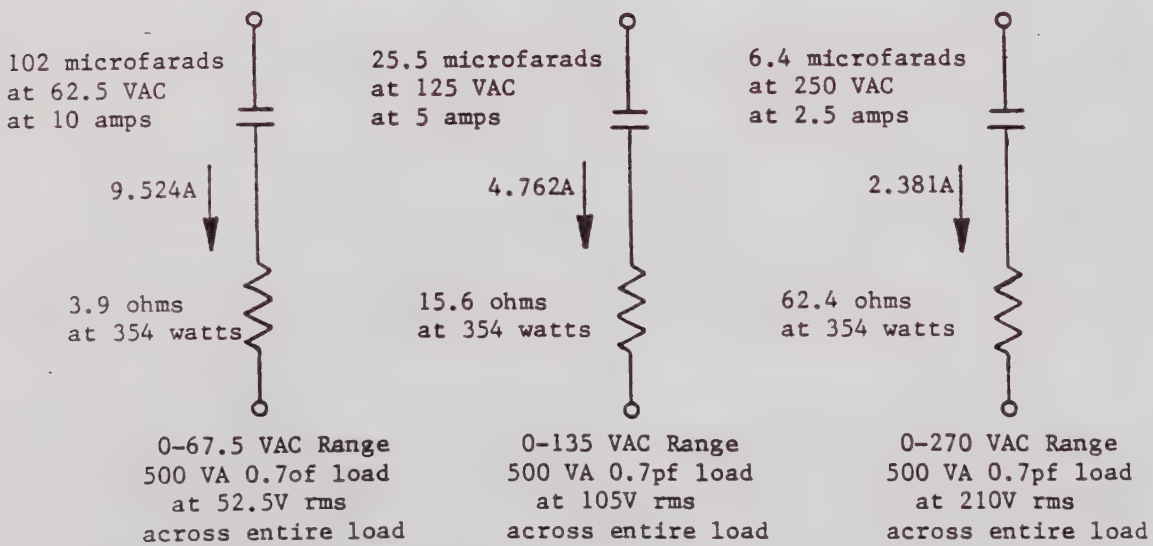


FIGURE 4.11B. Load Circuit for TA=55°C 0:7 Leading Power Factor at 400 Hz.

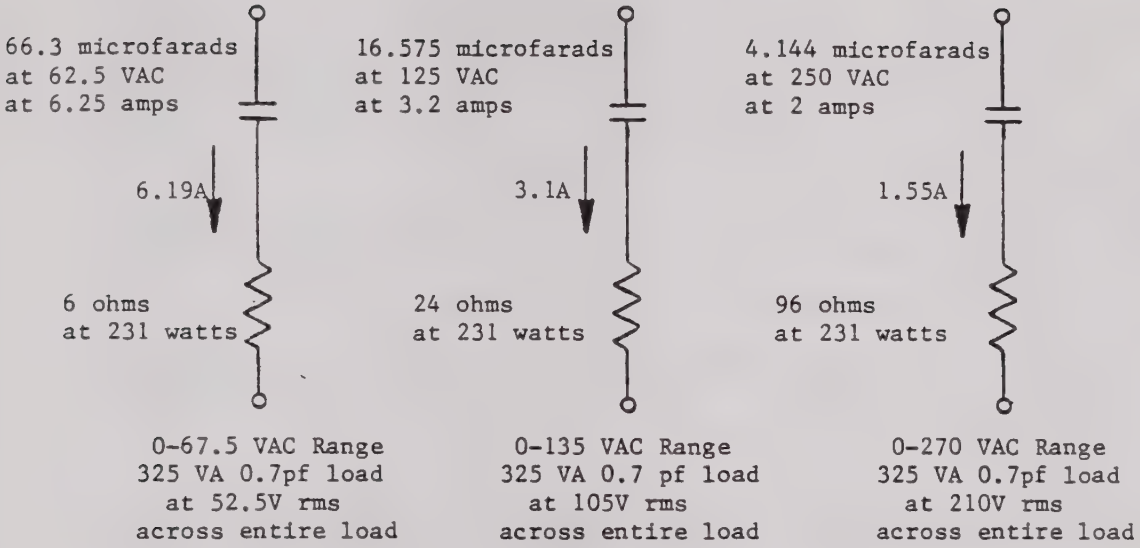


FIGURE 4.12A. Load Circuit for TA=25°C 0.7 Leading Power Factor at 400 Hz.

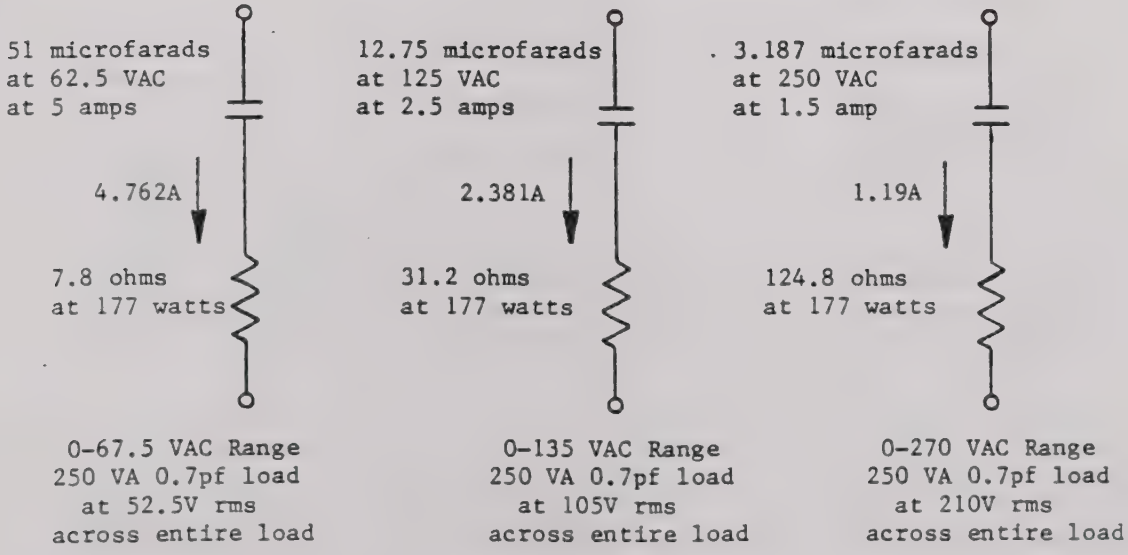


FIGURE 4.12B. Load Circuit for TA=55°C 0.7 Leading Power Factor at 400 Hz.

4.13 PROGRAMMABLE CURRENT LIMIT TEST

The current limit test will verify the ability of the power source to limit the output if the peak output current exceeds the programmed values. Depending on the amount of overload, there will either be clipping on the positive and negative peaks of the output waveform or the output will be completely shut down. Tables 4-5-1 through 4-5-4 show the peak current values equivalent to the programmed DC voltages.

If not already accomplished, connect the power source and test equipment as per Figure 4-4.

4.13.1 Test Current Limit

1. Adjust the autotransformer for 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP. Set oscillator frequency to 400 Hz.

2. Select the 135 VAC output range.

3. Set up the load assembly with the proper full power resistive load from Tables 4-5-1 through 4-5-4.

4. Connect the programmable DC source to the interface connector, pin 1, Low and pin 29, Hi.

5. Program the DC voltage for 5 ±1 VDC.

6. Turn unit "ON".

7. Set frequency to 400 Hz.

8. Adjust AMPLITUDE contro for 105 VAC output.

9. Apply 100% load for 78% of rated output. Reference Tables 4-5-1 through 4-5-4.

10. Slowly program the DC voltage to the value given in Table 4-5-1 through 4-5-4 while observing the output waveform with the oscilloscope. Note the DC voltage where limiting begins. This value should be within ±5% of the value given in Table 4-5-1 through 4-5-4.

11. Repeat step 10 for 50% load.

12. Repeat step 10 for 10% load.

TABLE 4-5-1

LOAD RESISTOR AND CURRENT LIMIT
PROGRAM VALUES FOR 1031XP

PERCENT RATED RATED CURRENT	OUTPUT VOLTAGE	LOAD RESISTOR			CURRENT LIMIT DC PROGRAMMING LEVEL		
		52.5VAC	105VAC	210VAC	52.5VAC	105VAC	210VAC
100%		2.1	8.5	33.9	3.45	1.73	.865
50%		4.2	17.0	67.8	1.73	.865	.432
10%		21.2	84.8	339.2	.345	.173	.086

All Resistor values in ohms

TABLE 4-5-2

LOAD RESISTOR AND CURRENT LIMIT
PROGRAM VALUES FOR 971XP

PERCENT RATED RATED CURRENT	OUTPUT VOLTAGE	LOAD RESISTOR			CURRENT LIMIT DC PROGRAMMING LEVEL		
		52.5VAC	105VAC	210VAC	52.5VAC	105VAC	210VAC
100%		2.8	11.3	45.2	2.59	1.295	.647
50%		5.6	22.6	90.5	1.295	.647	.324
10%		28.3	113.1	452.3	.259	.129	.065

All resistors values in ohms

TABLE 4-5-3

LOAD RESISTOR AND CURRENT LIMIT
PROGRAM VALUES FOR 651XP

PERCENT RATED RATED CURRENT	OUTPUT VOLTAGE	LOAD RESISTOR			CURRENT LIMIT DC PROGRAMMING LEVEL		
		52.5VAC	105VAC	210VAC	52.5VAC	105VAC	210VAC
100%		4.2	16.9	67.8	1.71	.855	.428
50%		8.5	33.92	135.7	.855	.428	.214
10%		42.4	169.6	678.5	.171	.085	.043

All resistor values in ohms

TABLE 4-5-4

LOAD RESISTOR AND CURRENT LIMIT
PROGRAM VALUES FOR 321XP

PERCENT RATED RATED CURRENT	OUTPUT VOLTAGE	LOAD RESISTOR			CURRENT LIMIT DC PROGRAMMING LEVEL		
		52.5VAC	105VAC	210VAC	52.5VAC	105VAC	210VAC
100%		8.5	33.9	135.7	.855	.427	.214
50%		16.9	67.82	271.4	.427	.214	.107
10%		84.8	339	1,357	.086	.043	.021

All resistor values in ohms

4.14 24 HOUR AMPLITUDE STABILITY TEST

If not already accomplished, connect the power source and test equipment per Figure 4-2 and 4-3.

1. Adjust the autotransformer to 115 VAC for the 321XP and 651XP or 230 VAC for the 971XP and 1301XP.

2. Turn unit "ON" and set output amplitude to 105 VAC.

3. Apply 100% load for 78% of rated output. Reference Tables 4-3-1 thourgh 4-3-4.

4. Allow unit to warm up for one hour.

5. Select program number five of Keithley Programmable DMM Model 192. Record the reading on the DMM at this time.

6. Allow unit to operate for 24 hours.

7. At the end of the test period, select the readout function to retrieve the high and low values. The maximum and minimum values should not be greater than 0.25% of value recorded at the start of the test.

NOTE: Care should be taken to ensure that the ambient temperature is held constant at ±3 degrees centigrade for this test.

WARNING

HIGH VOLTAGE (270 VAC)

Voltages up to 270 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

On contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with the primary power circuits, and the output circuits of the power source.

SECTION V

MAINTENANCE AND TROUBLESHOOTING

5.1 GENERAL

The California Instruments XP Series AC Power Sources are solid state units and should require a minimum of maintenance. However, they are force air-cooled and will accumulate some dust with time. The power transistor heatsinks should receive a forced air bath at intervals not to exceed six months.

Heatsink Cleaning:

CAUTION

Failure to keep the heatsinks clean will reduce their thermal efficiency and could cause failure of the power source.

1. Remove the power from the power source.
2. Remove the top cover of the unit and the top cover of the heatsink wind tunnel.
3. Slide inboard side of wind tunnel up and out of its slot.
4. Unplug and remove heatsinks.
5. Blow heatsinks clean with compressed air from inside toward outside of convoluted fin sections.

5.2 TROUBLESHOOTING

5.2.1 External Checks

If the problem appears to be the AC power source, perform the following checks before removing the covers.

1. Measure the MAINS input for proper voltage and frequency for the input range selected.
2. Disconnect the load from the output terminals, TB2.
3. Turn the unit "ON".
4. The front panel OVERLOAD lamp should come on and then within a few seconds go out.

   If the OVERLOAD lamp stays on, this is an indication that the power source is in need of repair. Proceed to paragraph 5.

5. If the OVERLOAD and OVERTEMP lamps are both on, then the problem is in either the temperature sense circuitry or the power amplifier (G3) section. Proceed to paragraph 5.2.2.2 for the temperature sense checks or paragraph 5.2.2.5 for the power amplifier.

6. If all checks are satisfactory to this point, measure the oscillator signal at the interface connector (J1) on the rear panel. Note the position of the phase selector switch and measure the appropriate oscillator signal;

   J1, pin 1 - signal low
   J1, pin 26 - øA oscillator
   J1, pin 27 - øB oscillator
   J1, pin 28 - øC oscillator

   These signals should be approximately 5V rms for full scale output.

7. If the oscillator signal is the proper amplitude and frequency, turn the power off, remove the cover and check continuity between the interface connector and oscillator input signal on A3.

If the oscillator signal is present at A3, refer to section III of this manual for Theory of Operation and trace signal through the amplifier.
If the oscillator signal is not present, then refer to chassis schematic, 4000-088, to trace the oscillator signal.

5.2.2 Internal Checks

5.2.2.1 DC Power Supply

1. Refer to Table 4-4 and Figure 4-1 for power supply test points and voltages.

5.2.2.2 Protection Circuits

1. Check output of temperature sense circuits. This voltage should be more than 6.4 VDC reverse biasing the ORing diodes.

2. The output of the current sense circuit should be approximately zero at no load and 10 ±.1V peak at full load.

3. The output of the transistor Vce circuit should be >5.5 VDC.

4. If steps 1, 2, and 3 are OK, the output of the integrator should be approximately 14 VDC and the green LED, A3DS1, should be fully on.

5. If steps 4 is OK, the trouble is either in the preamplifier or power amplifier.

5.2.2.3 Preamplifier

1. Check signal at input to preamplifier.

2. Check signal at output of buffer amplifier.

3. Check signal at output of error amplifier. This signal is a distorted sine wave approximately 5V peak at full scale.

4. Check the output of the error amplifier with no signal. This should be less than $\pm$0.6 VDC. A voltage greater than this means an unbalance in the level shifter or power amplifier.

5.2.2.4 Level Shifter

1. At no signal input, check the DC level at the output of the level shifter. This should be zero $\pm$50mV.

2. At full scale output, the level shifter should ve very close to the primary voltage at no load.

3. If the signal here is very distorted even at no load, the problem may be in the power amplifier.

4. If the signal is highly distorted, then turn the unit off, remove the heatsinks and disconnect the wire to T2-2. Jumper A3R155 (P1-92 end) to A3TP26.

5. Reapply power and recheck the signal at the output of the level shifter. If the signal is a clean sine wave, the problem is most likely in the power amplifier (G3).

5.2.2.5 Power Amplifier

1. If the problem appears to be in the power amplifier, turn the unit off. Reinstall the heatsinks leaving T2-2 disconnected.

2. Turn unit on and observe the waveform at the output of the level shifter. The portion of the sine wave that is distorted should indicate which polariy of the heatsinks is damaged.

3. If the output of the level shifter looks OK, then the problem in the power amplifier could be a function of load current. Connecte a small load (50 ohm/50W) between T2-1 and the lead which was disconnected from T2-2.

4. Observe the output of the level shifter. If the waveform still does not show any distortion, the problem may require heavier loading of amplifier.

5. When the defective polarity has been identified, turn the unit off and remove the heatsinks and isolate the defective transistor or associated component on the heatsink using the multimeter.

SECTION VI

CIRCUIT DIAGRAMS

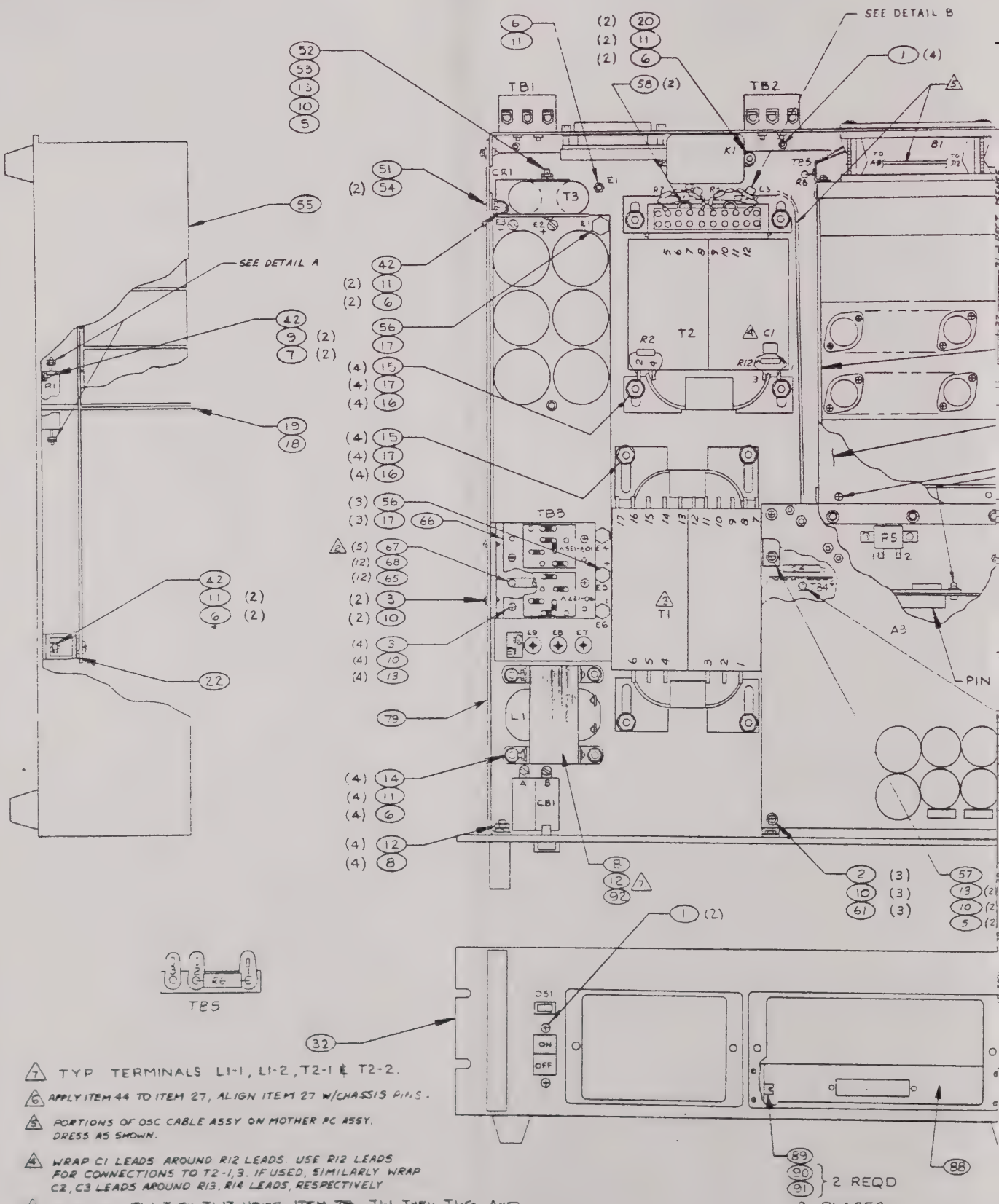
6.1 GENERAL

This section contains schematics and mechanical diagrams necessary for operation and maintenance of the XP Series Power Sources. The schematic diagrams illustrate the circuit while the mechanical assemblies indicate the part placement.

6.2 REFERENCE DESIGNATIONS

Partial reference designators are shown on the schematic and mechanical drawings. To determine the complete reference designator, prefix the schematic or drawing reference designator with the assembly and/or sub-assembly designator. For example:

Assembly/Sub-Assembly	Component	Component Designation
A1	C8	A1C8
None	T1	T1



7 TYP TERMINALS L1-1, L1-2, T2-1 & T2-2.

6 APPLY ITEM 44 TO ITEM 27, ALIGN ITEM 27 W/CHASSIS PINS.

5 PORTIONS OF OSC CABLE ASSY ON MOTHER PC ASSY. DRESS AS SHOWN.

4 WRAP C1 LEADS AROUND R12 LEADS. USE R12 LEADS FOR CONNECTIONS TO T2-1,3. IF USED, SIMILARLY WRAP C2, C3 LEADS AROUND R13, R14 LEADS, RESPECTIVELY

3 INSULATE T1-1 THRU T1-17 USING ITEM 78, T1-1 THRU T1-6 AND T1-10 THRU T1-17 TO BE SOLDERED / T1-7 THRU T1-9 SEE DETAIL D.

2 FASTEN ITEM 67 PER 103-135 V DIAGRAM

1 SEE DETAIL A INSTRUCTIONS FOR R1 MDWE ASSY

NOTES: (UNLESS OTHERWISE SPECIFIED)

8 7 6 5

REVISIONS			
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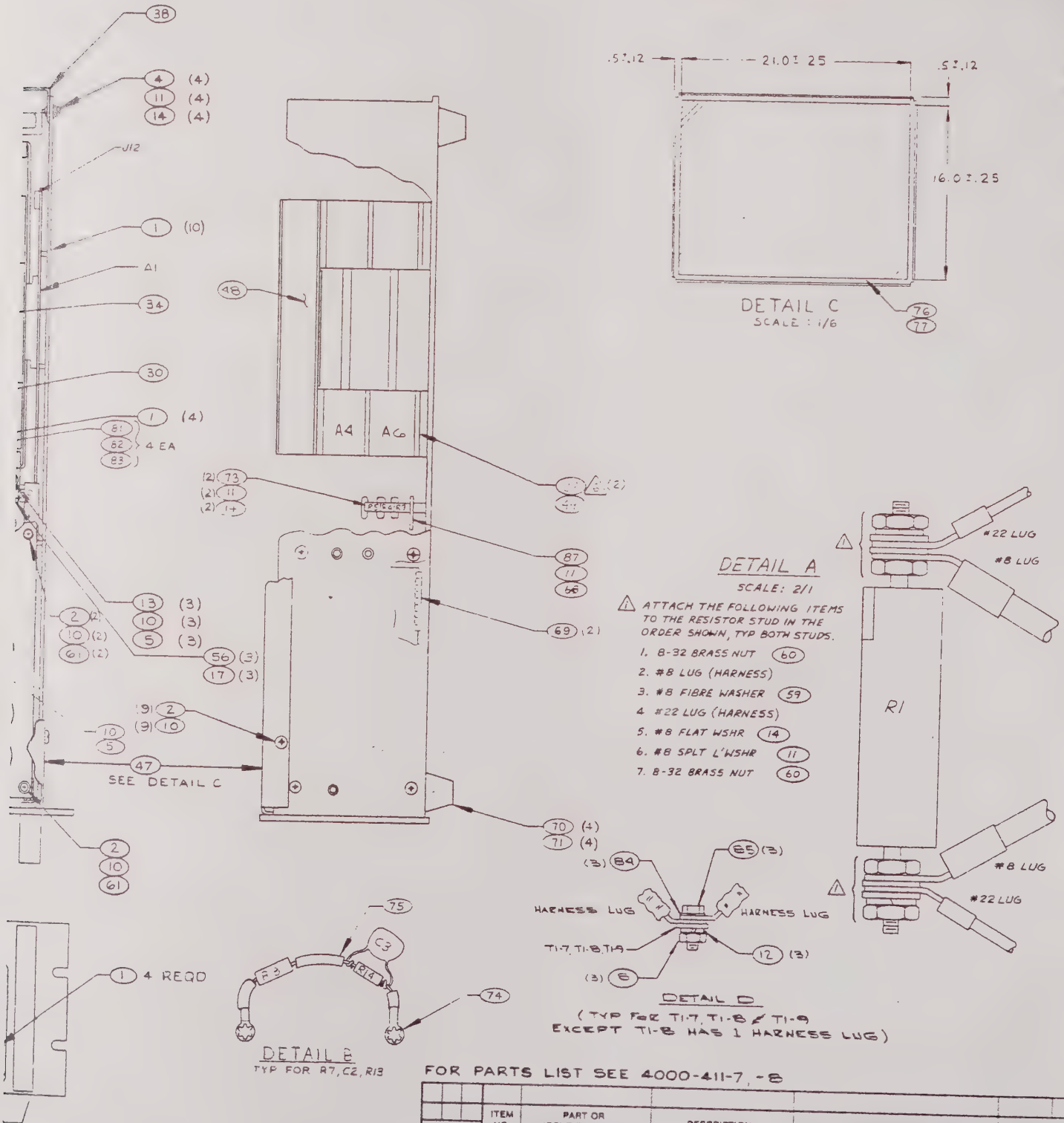
V	NEW PREAMP	4-6-87	



FOR PARTS LIST SEE 4000-411-7, -8

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

DIM IN INCHES
TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE D

TITLE: TOP ASSY

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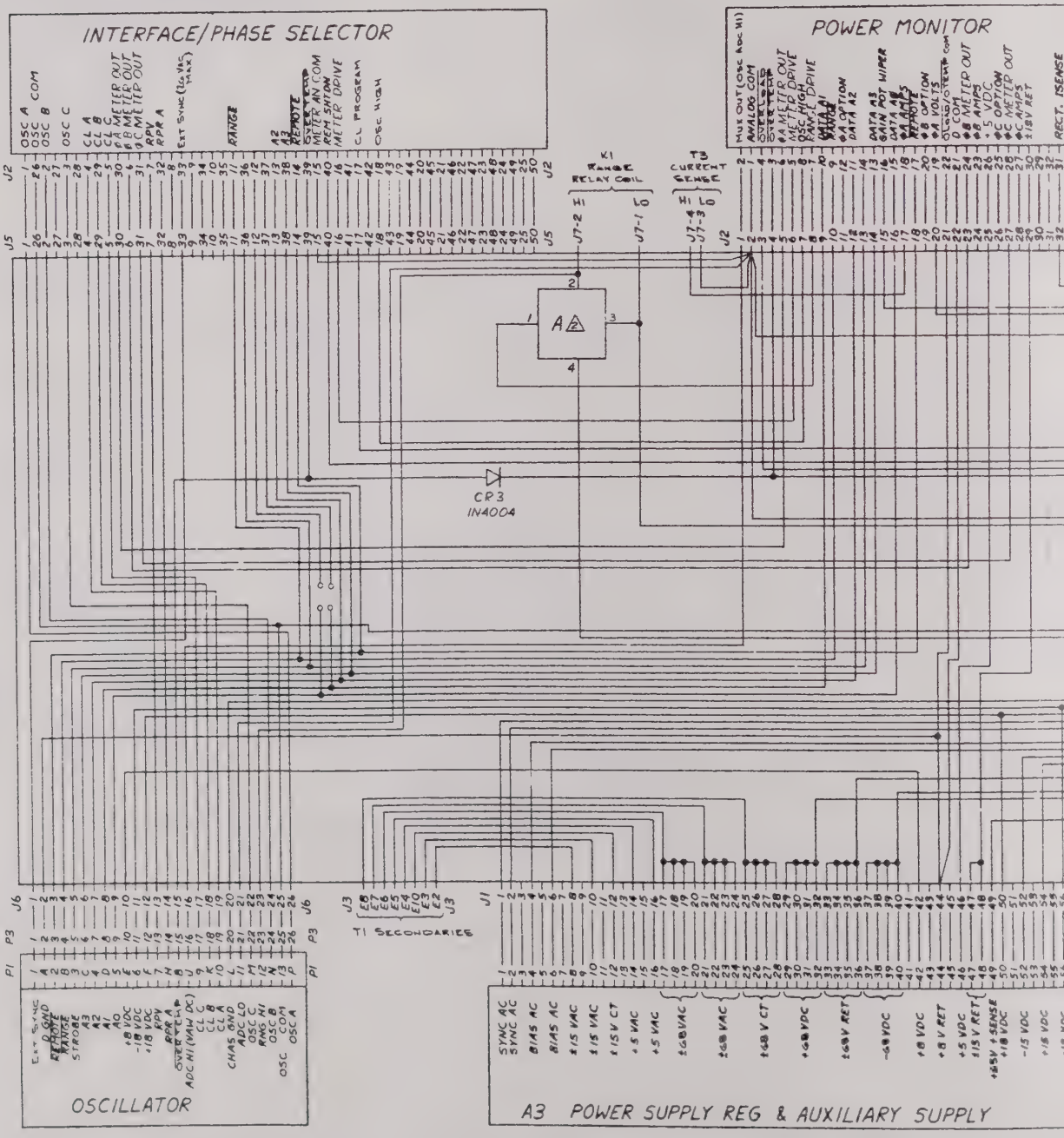
			ADDITIONAL APPROVALS
RELEASE			
PROJ ENG	J ROUSE	2-12-87	
CHECK	ERWINE	2-11-87	
DESIGN			
DRAFT	BEACH	2/87	

CONTRACT NO
CODE IDENT 16067
DWG NO 4000-411
SCALE 1/2
SHEET 1 OF 1

QTY REQD	USED ON	NEXT ASSY
	651XP	END ITEM



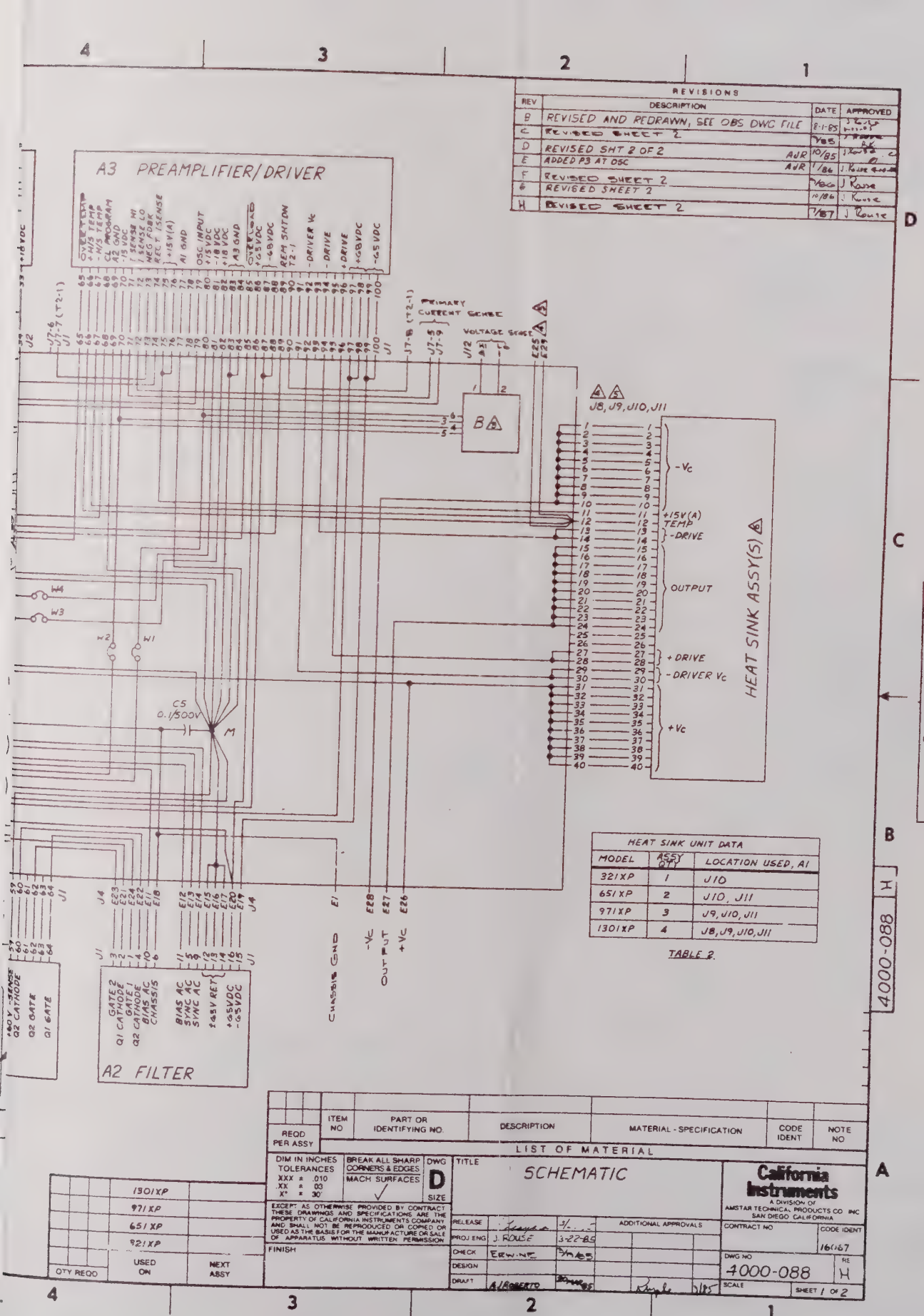
NOTES CONTINUED ON SHT 2

4. FOR HEAT SINK ASSY QTY & LOCATION(S), SEE TABLE 2.
5. CONNECTIONS TO PIN 12 SHOWN ARE A COMPOSITE OF CONNECTIONS TO J8, J9, J10, J11. SEE TABLE 1 FOR ACTUAL CONNECTIONS.
6. J8 & E29 EXIST ONLY ON MOTHER PC ASSY OF 1301XP.
7. SEE SHEET 2 FOR DETAIL OF VOLTAGE SENSOR CIRCUIT B.
8. SEE SHEET 2 FOR DETAIL OF RELAY SWITCH CIRCUIT A.
1. FOR WIRE TAB TABLE, SEE WTT 4000-050

NOTES (UNLESS OTHERWISE SPECIFIED)

TEMP SENSING DATA		
FROM	TO	DESCRIPTION
J8-12	E29	SPARE +TEMP
J9-12	J1-66	+H/S TEMP
J10-12	J1-67	-H/S TEMP
J11-12	E25	SPARE -TEMP

TABLE 1



REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
B	REVISED AND REDRAWN, SEE OBS DWG FILE	8-1-85	J. ROUSE
C	REVISED SHEET 2	1985	J. ROUSE
D	REVISED SHT 2 OF 2	10/85	J. ROUSE
E	ADDED P3 AT OSC	1/86	J. ROUSE
F	REVISED SHEET 2	1986	J. ROUSE
G	REVISED SHEET 2	10/86	J. ROUSE
H	REVISED SHEET 2	7/87	J. ROUSE

HEAT SINK UNIT DATA		
MODEL	ASSY QTY	LOCATION USED, A1
321XP	1	J10
651XP	2	J10, J11
971XP	3	J9, J10, J11
1301XP	4	J8, J9, J10, J11

TABLE 2.

ITEM NO	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REQD PER ASSY					

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY
	1301XP	
	971XP	
	651XP	
	321XP	

DIM IN INCHES
TOLERANCES
.XXX ± .010
.XX ± .03
X° ± 30'

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DWG SIZE D

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FINISH

TITLE: SCHEMATIC

RELEASE			ADDITIONAL APPROVALS
PROJ ENG	J. ROUSE	3-22-85	
CHECK	ERWIN	3/1985	
DESIGN			
DRAFT	A. ROBERTO	3/1985	

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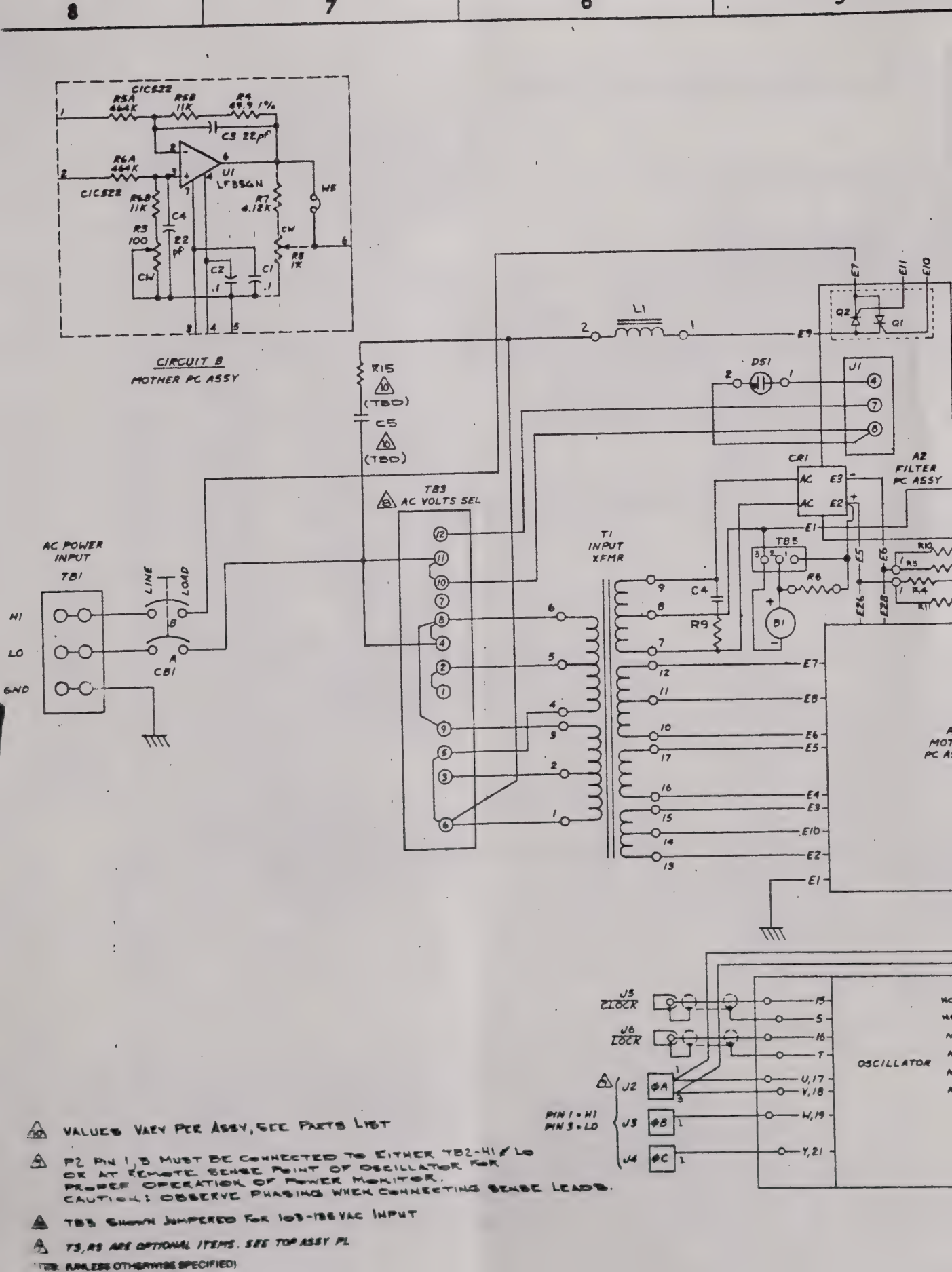
CONTRACT NO
CODE IDENT 16167
DWG NO 4000-088
RE H
SCALE
SHEET 1 OF 2

4000-088 1 of 2

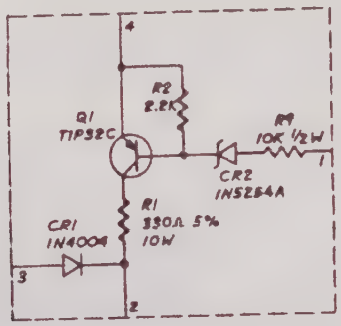
4000-088 H



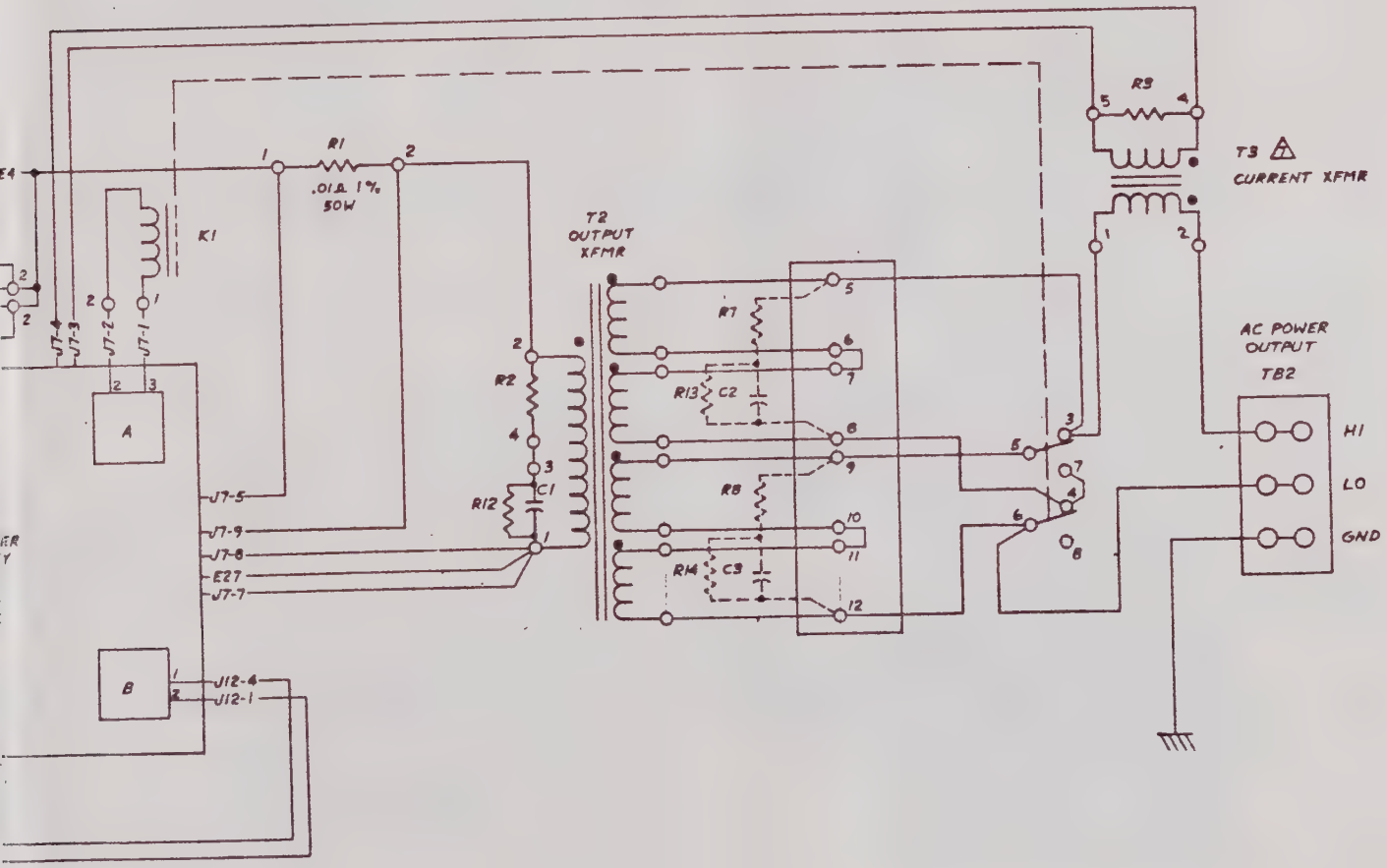
1. VALUES VARY PER ASSY, SEE PARTS LIST
2. P2 PIN 1, 3 MUST BE CONNECTED TO EITHER TB2-HI & LO OR AT REMOTE SENSE POINT OF OSCILLATOR FOR PROPER OPERATION OF POWER MONITOR. CAUTION: OBSERVE PHASING WHEN CONNECTING SENSE LEADS.
3. TB3 SHOWN JUMPERED FOR 103-126 VAC INPUT
4. T3, R9 ARE OPTIONAL ITEMS. SEE TOP ASSY PL

NOTE: UNLESS OTHERWISE SPECIFIED

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ADDED CR2 & R9, REV T3. ADDED E1, R6,7,8,9, C2,3,4		
B	REVISED NOMENCLATURE		
C	REVISED J2 HOOK-UP		
D	ADDED R12, R13, R14 AJR	10/85	
E	APPENDED PC ASSY BLOCK TO OSC AJR		
F	REVISED HOOK UP OF L1 AND CB1		
G	CIRCUIT CHANGE, ADD TB3		
H	ADDED R15 & C5		



CIRCUIT A
MOTHER PC ASSY



ITEM NO	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REQD PER ASSY					

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY
1301XP		
971XP		
651XP		
321XP		

DIM IN INCHES TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

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DWG SIZE D

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TITLE SCHEMATIC

REL BASE	A Ledyard	9/15/85
PROJ ENG	J. ROUSE	3-22-85
CHECK	E. WYNNE	9/9/85
DESIGN		
DRAFT	AJ ROBERTO	

ADDITIONAL APPROVALS

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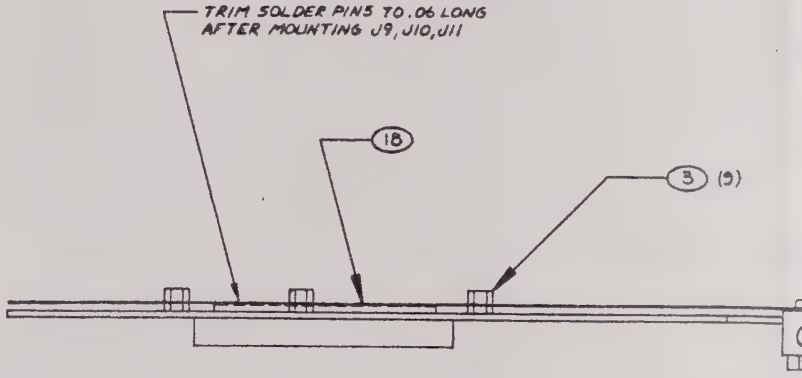
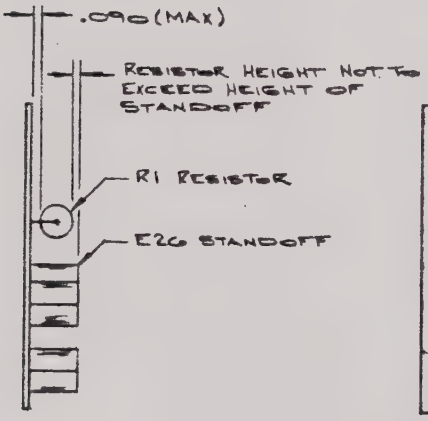
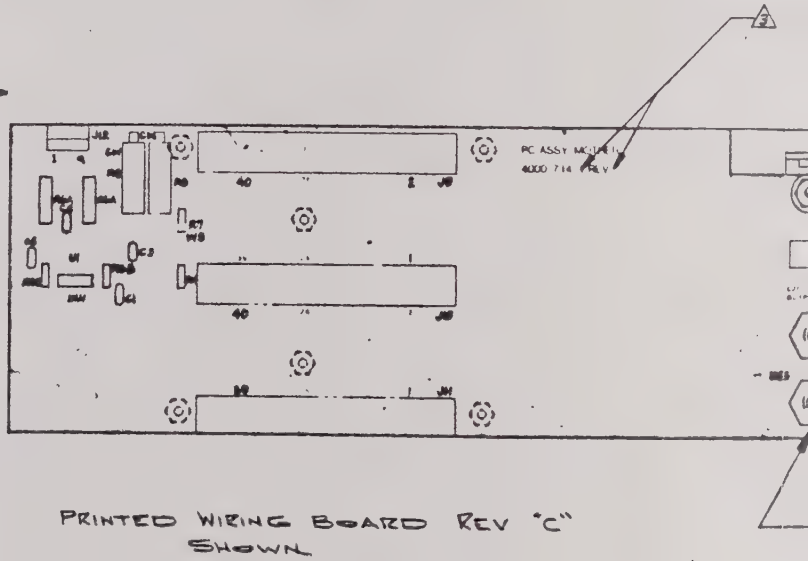
CONTRACT NO. —
CODE IDENT 76067
DWG NO 4000-088
REV H
SCALE
SHEET 2 OF 2





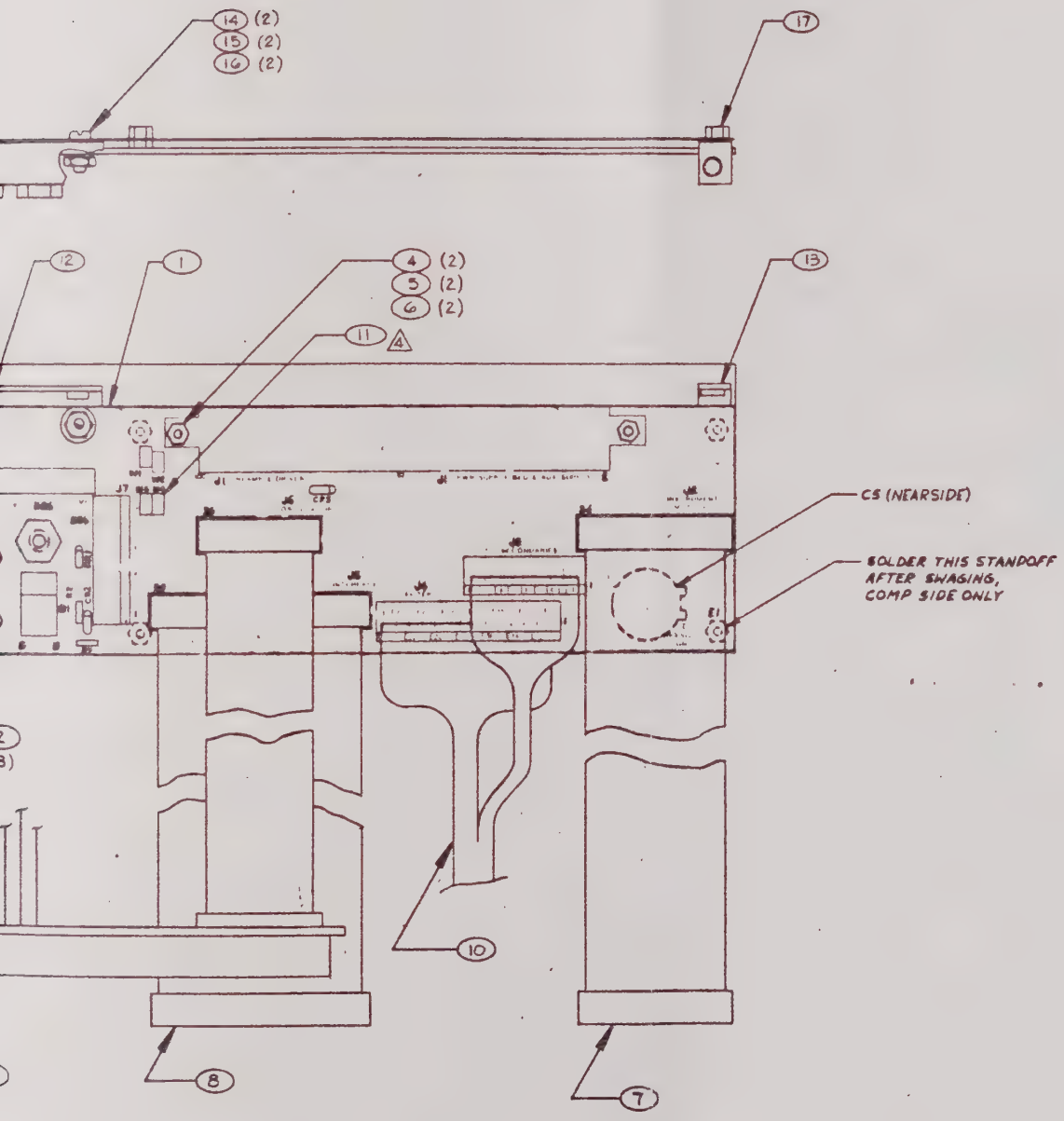


PRINTED WIRING BOARD REV "C"
SHOWN

⚠4 BREAK THIS ITEM INTO 4 8-PIN PIECES BEFORE MOUNTING
⚠3 MARK WITH REVISION LTR OF THIS DRAWING & APPROPRIATE PART NO.
2. FOR SCHEMATIC, SEE 4000-068
⚠1 FOR PARTS LIST, SEE PL 4000-714-1

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
C	REVISED AND REDRAWN, SEE OBS DWG FILE	6-6-85	
D	REVISED ITEM 9, DELETE PL -2, -4, -8 AMR	8/8/85	J. Kouse
E	ADDED CIRCUIT SIDE REWORK	8/16/85	
F	INCORPORATE MISSING CLAD	8/16/85	
G	REVISED PARTS LIST	9/16/85	J. Kouse



ITEM NO.	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT.	NOTE NO.	REQD PER ASSY
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1	65IXP	4000-411				1
2	32IXP	4000-412				1

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY

DIM IN INCHES TOLERANCES .XXX ± .010 .XX ± .03 X° ± 30'

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DWG SIZE D

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TITLE PC ASSY, MOTHER

A1

			ADDITIONAL APPROVALS
PREPARED	R. Ledyard	8/21/85	
PROJ ENG	J. Kouse	9-11-85	
CHECK	Erwine	9/11/85	
DESIGN			
DRAFT	J. SPROAT	8-6-85	

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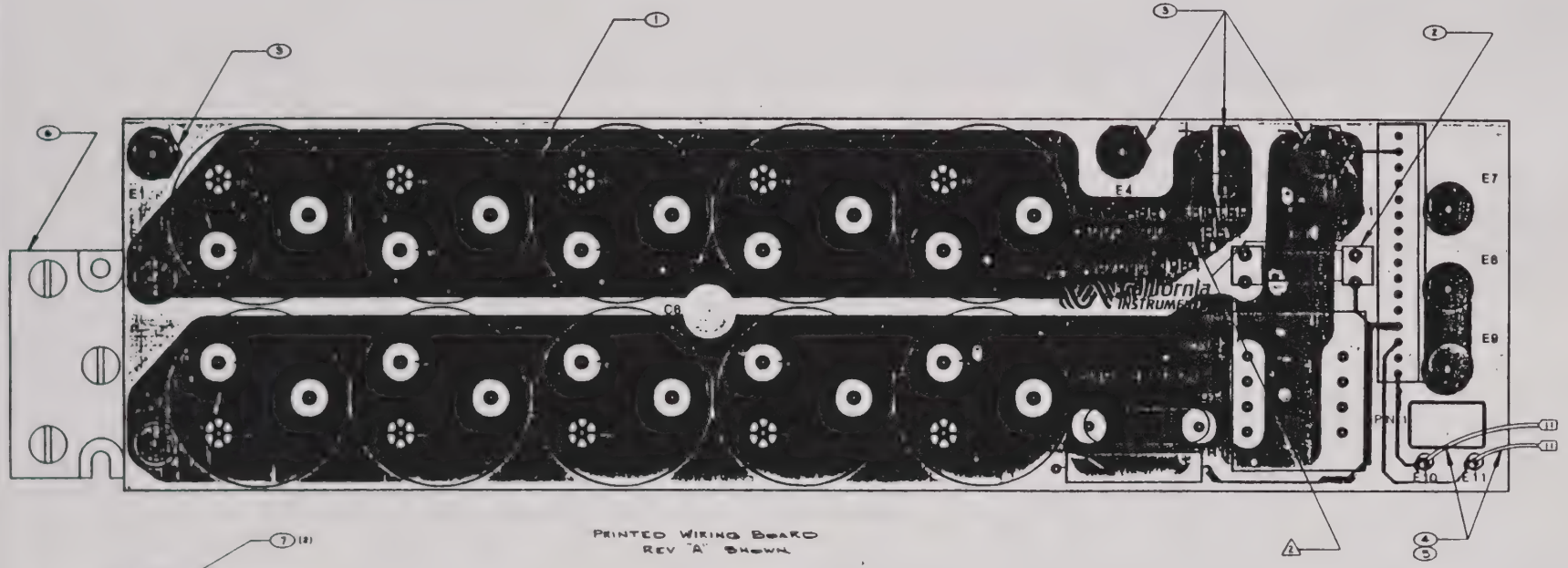
CONTRACT NO. | CODE IDENT. 16067

DWG NO. 4000-714 | REV G

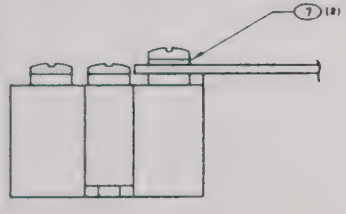
SCALE 1/1 | SHEET 1 OF 1

4000-714

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ENLARGE CTR MOUNTING HOLE TO .339	1/4/85	J Ross
B	REVISED STANDOFFS		
C	REVISED VALUE OF R1 WAS 402Ω		J Ross



PRINTED WIRING BOARD
REV "A" SHOWN



⚠ MARK WITH APPROPRIATE DASH NUMBER & REV LTR

1. FOR SCHEMATIC SEE 4000-081

NOTES (UNLESS OTHERWISE SPECIFIED)

FOR PARTS LIST SEE 4000-700-1,2,3,4

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REQD PER ASSY		LIST OF MATERIAL			

1			1304EP	4000-409	
1			9718P	4000-410	
	1		6818P	4000-411	
		1	5818P	4000-412	
-4	-3	-2	-1	USED ON	NEXT ASSY
QTY REQD					

DIM IN INCHES TOLERANCES .XX ± .010 .X ± .05 F ± .10

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES

DWG SIZE D

TITLE: PRINTED CIRCUIT ASSY FILTER A2

California Instruments

DRAWN	J Ross	10/1/84	
TRACED	J Ross	1/2/85	
CHECK	E Wine	1/9/85	
DESIGN			
DRAFT	R Gervais	1/5/84	

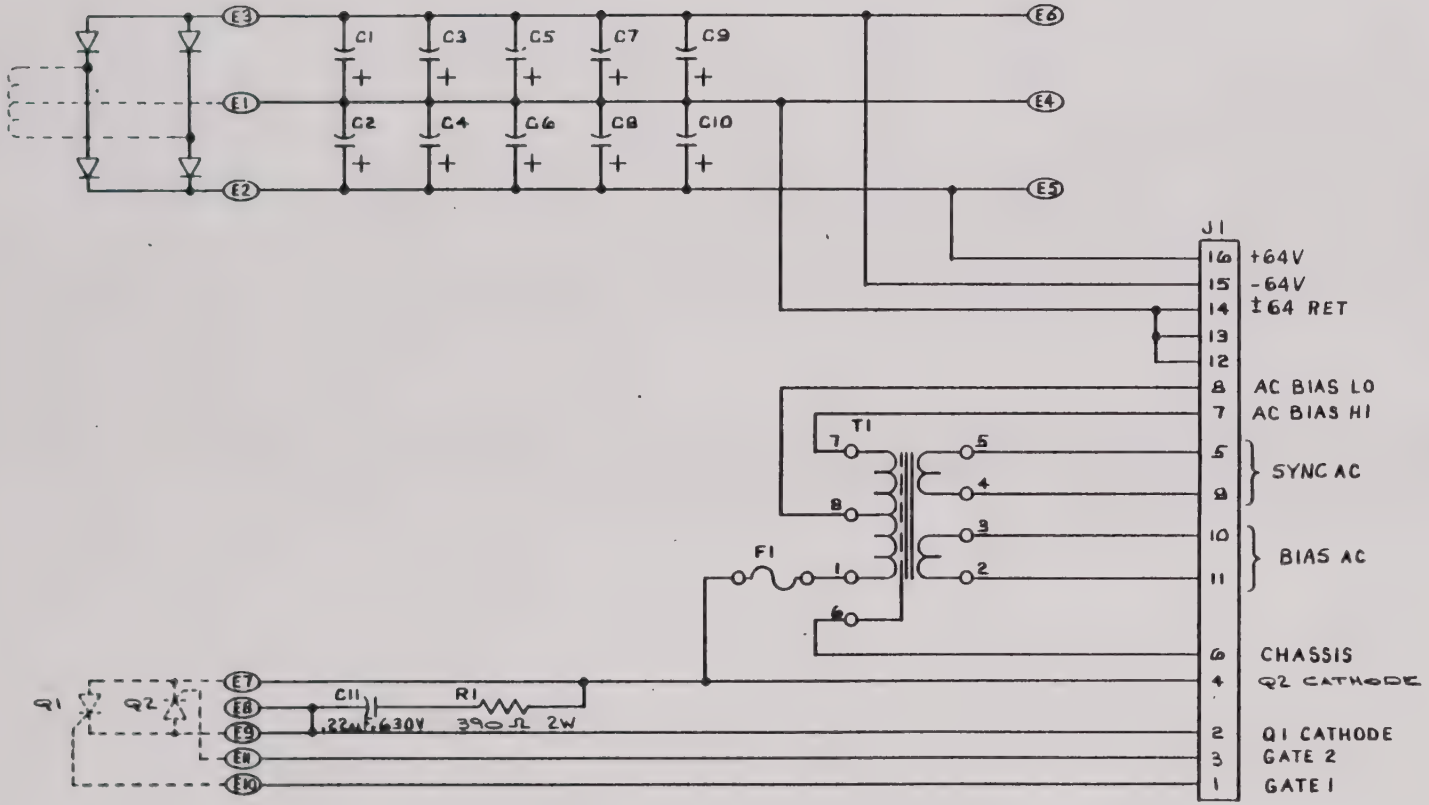
ADDITIONAL APPROVALS

CONTRACT NO 4067

DWG NO 4000-700 REV C

SCALE 2/1 SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	EXCH SYNC & BIAS 64V WAS 60V ADR	10APR 85	
B	REVISED R1 WAS 40Ω 7W	4/86	J. Rouse



ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO	REQD PER ASSY
		LIST OF MATERIAL				

QTY REQD	USED ON	NEXT ASSY
	1301XP	4000-700-4
	971XP	4000-700-3
	651XP	4000-700-2
REF	321XP	4000-700-1

1. C1 THRU C10 ARE 9500 μF, 75V

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES TOLERANCES: XXX ± .010, XX ± .03, X° ± 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES √
DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH

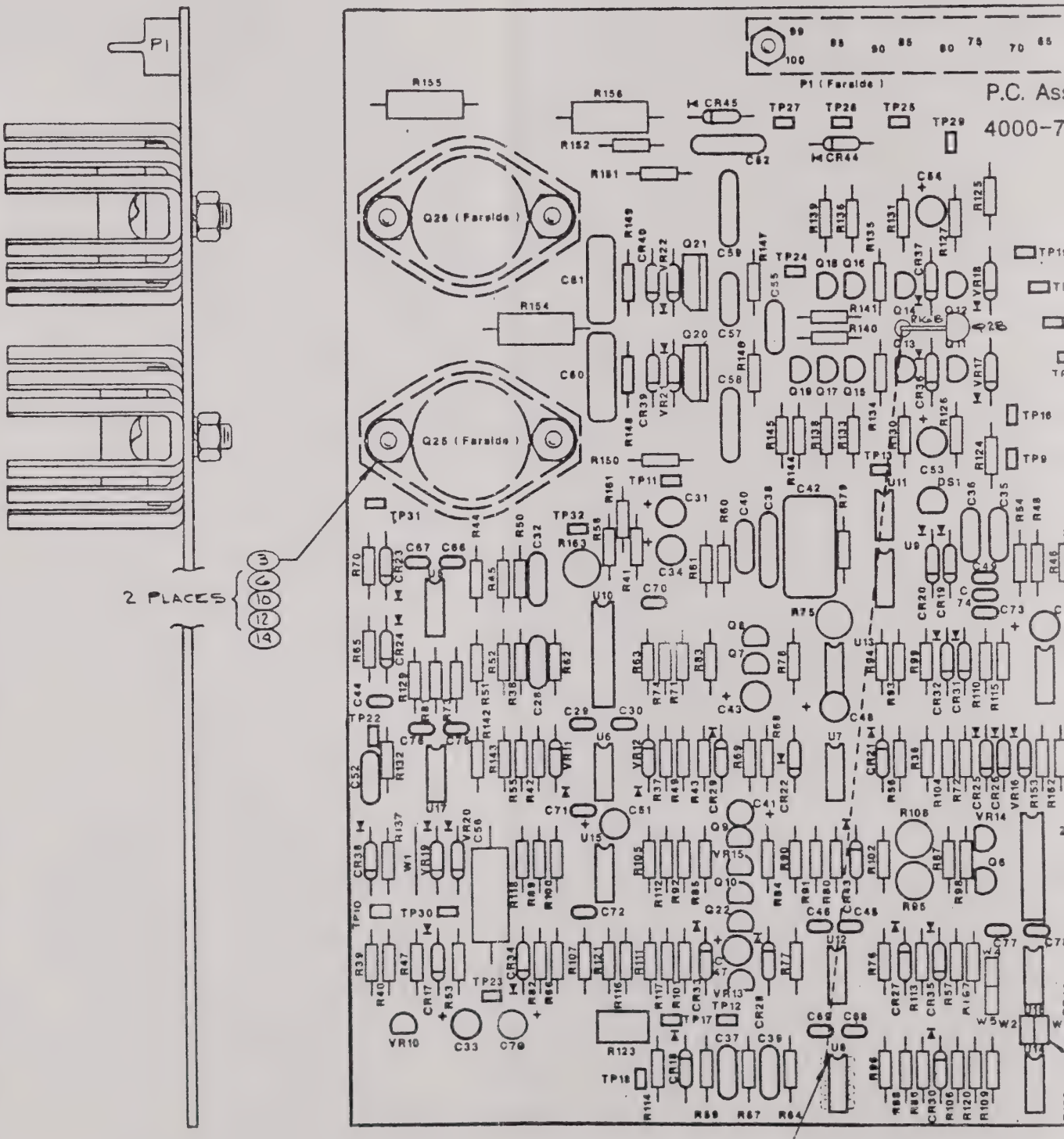
TITLE: SCHEMATIC, FILTER A2

			ADDITIONAL APPROVALS
RELEASE	P. Lockyard	3/25/85	
PROJ ENG	J. ROUSE	3-22-85	
CHECK	ERWINE	3/19/85	
DESIGN			
DRAFT	BEACH	8-84	Kuepa's

California Instruments
A DIVISION OF AMBAR TECHNICAL PRODUCTS CO INC SAN DIEGO CALIFORNIA

CONTRACT NO | CODE IDENT 16067
DWG NO. 4000-081 | REV B
SCALE NONE | SHEET 1 OF 1

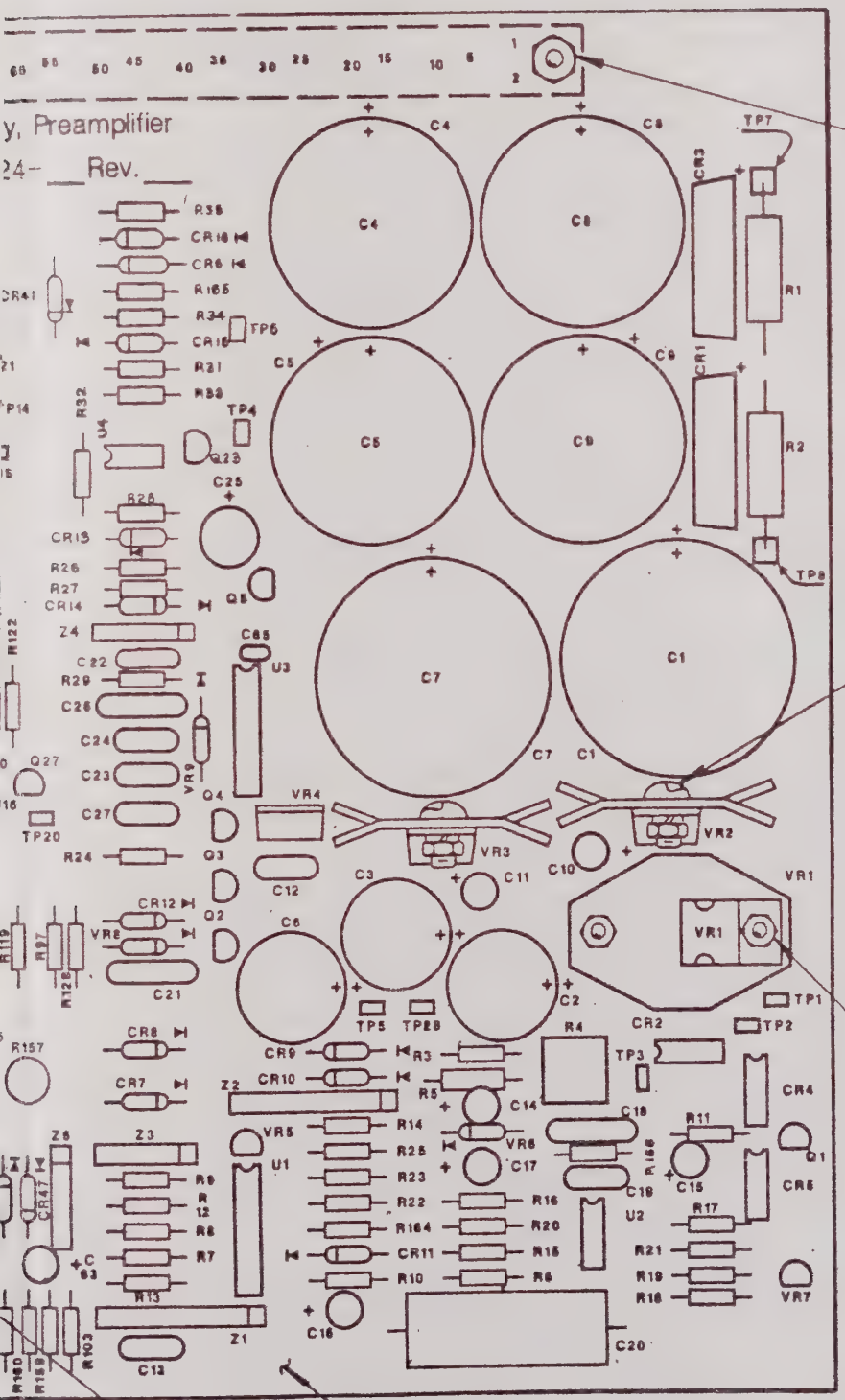
4000-081 B



1. FOR SCHEMATIC DIAGRAM SEE 4000-093.

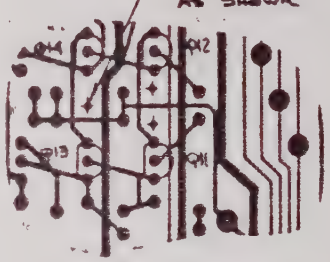
NOTES. (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
F	REVISED CIRCUITRY, REDRAWN	10/87	J Ruiz
G	ADDED Q2B AND R16B	11/88	J Ruiz



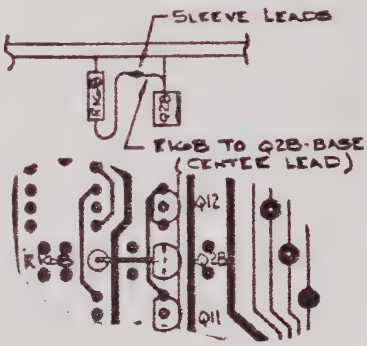
(8) (11) (13) } 2 PLACES

.032 DIA HOLE 3 PLACES AS SHOWN



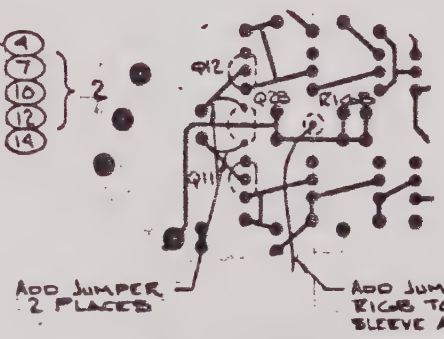
VIEW OF COMPONENT SIDE

(5) (9) (11) (13) (14) } 2



VIEW OF COMPONENT SIDE

(4) (7) (10) (12) (14) } 2



VIEW OF CIRCUIT SIDE

FOR PARTS LIST SEE 4000-T29-1 THRU -4

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
			LIST OF MATERIAL			

QTY REQD -4	-3	-2	-1	USED ON	NEXT ASSY
1				1301XP	4000-409
	1			971XP	4000-410
		1		651XP	4000-411
			1	321XP	4000-412

DIM IN INCHES TOLERANCES XXX ± .010 XX ± .03 X° ± 30'

BREAK ALL SHARP CORNERS & EDGES

MACH SURFACES ✓

DWG SIZE D

TITLE: PRINTED CIRCUIT ASSY PREAMP / POWER SUPPLY

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH

			ADDITIONAL APPROVALS
RELEASE	R Lockwood	10/87	
PROJ ENG	Jack Gross	10/87	
CHECK	ERWINE	10/87	
DESIGN			
DRAFT	DH ERWINE	10/87	

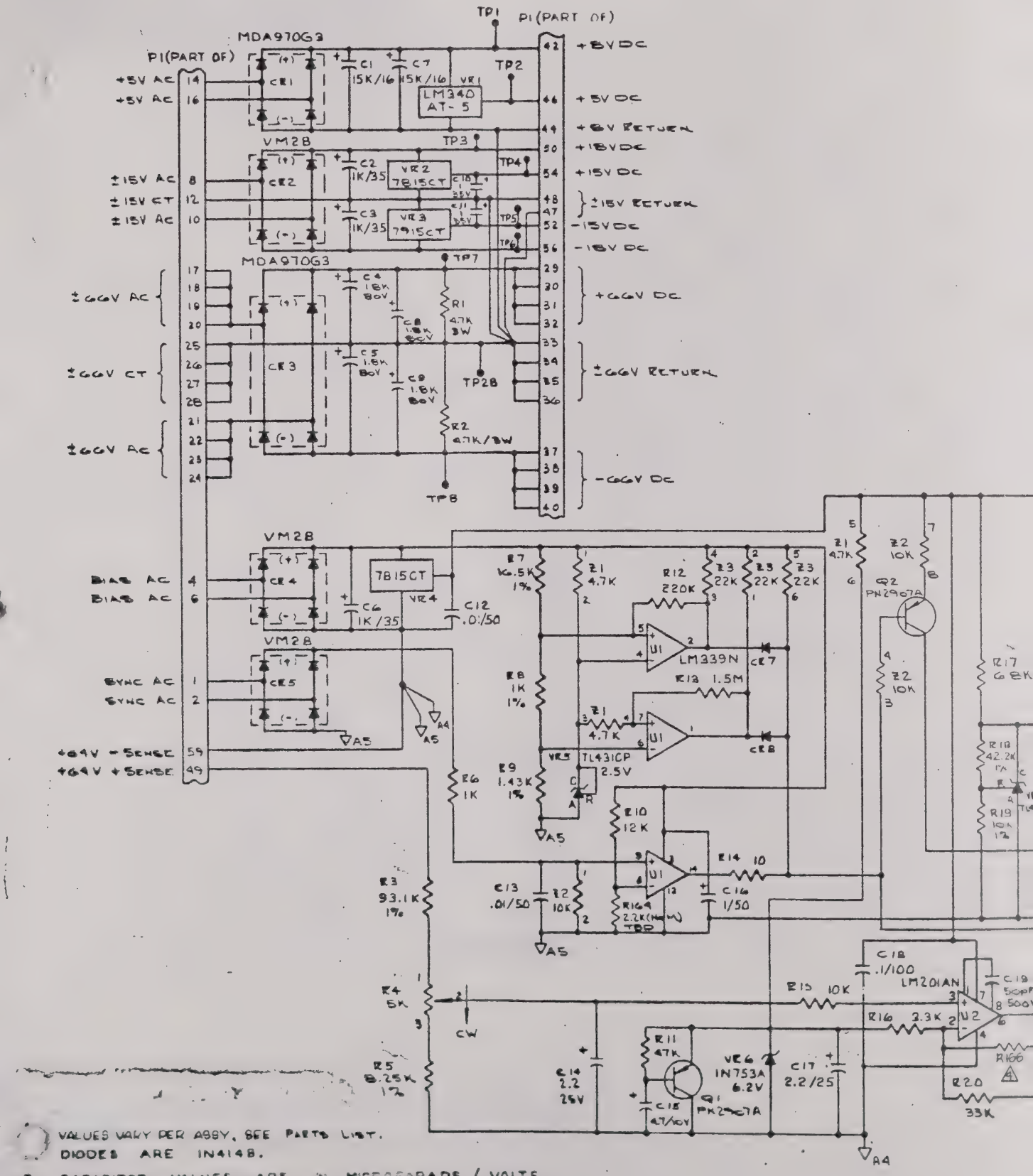
California Instruments — A DIVISION OF AMETAR TECHNICAL PRODUCTS CO SAN DIEGO CALIFORNIA

CONTRACT NO: 160

DWG NO: 4000-T29

SCALE 2/1 SHEET 1 OF

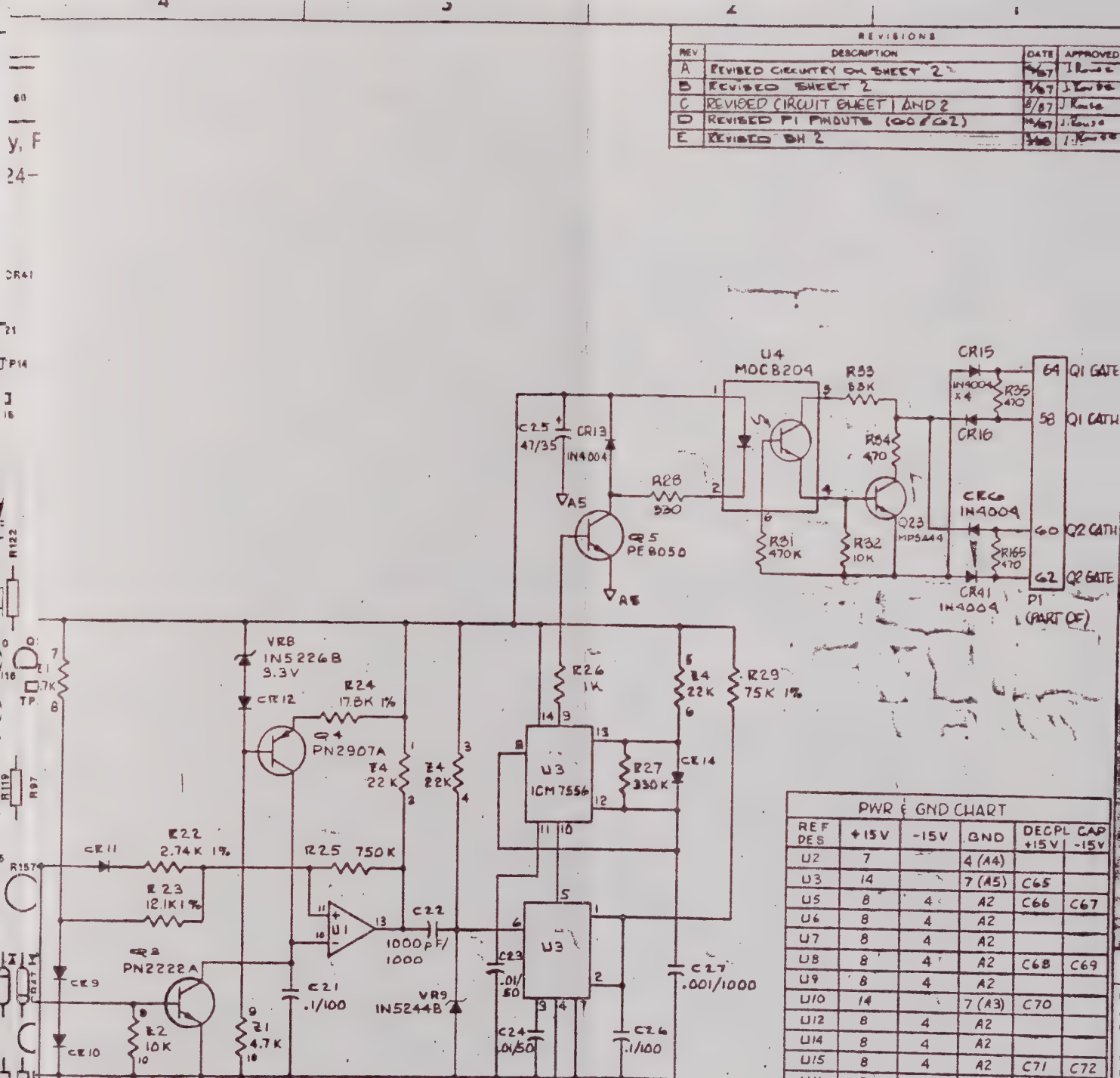
4 3 2 1



1. VALUES VARY PER ASSY, SEE PARTS LIST. DIODES ARE IN4148.
2. CAPACITOR VALUES ARE IN MICROFARADS / VOLTS.
1. RESISTORS ARE ¼ WATT, 5%. VALUE IS IN OHMS.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	REVISED CIRCUITRY ON SHEET 2	4/87	J Rouse
B	REVISED SHEET 2	7/87	J Rouse
C	REVISED CIRCUIT SHEET 1 AND 2	8/87	J Rouse
D	REVISED P1 PINOUTS (Q0 & Q2)	9/87	J Rouse
E	REVISED SH 2	9/87	J Rouse



PWR & GND CHART					
REF DES	+15V	-15V	GND	DECPL CAP +15V	-15V
U2	7		4 (A4)		
U3	14		7 (A5)	C65	
U5	8	4	A2	C66	C67
U6	8	4	A2		
U7	8	4	A2		
U8	8	4	A2	C68	C69
U9	8	4	A2		
U10	14		7 (A3)	C70	
U12	8	4	A2		
U14	8	4	A2		
U15	8	4	A2	C71	C72
U16	7	4	A1	C73	C74
U17	8	4	A2	C75	C76
U18	8	4	A2	C77	C78

ITEM NO	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REQD PER ASSY					

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY
1	1901 XP	4000-724
1	971 XP	4000-724
1	651 XP	4000-724
1	321 XP	4000-724

DIM IN INCHES
TOLERANCES
.XXX ± .010
.XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE D

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

FINISH

TITLE SCHEMATIC, BREAMPLIFIER

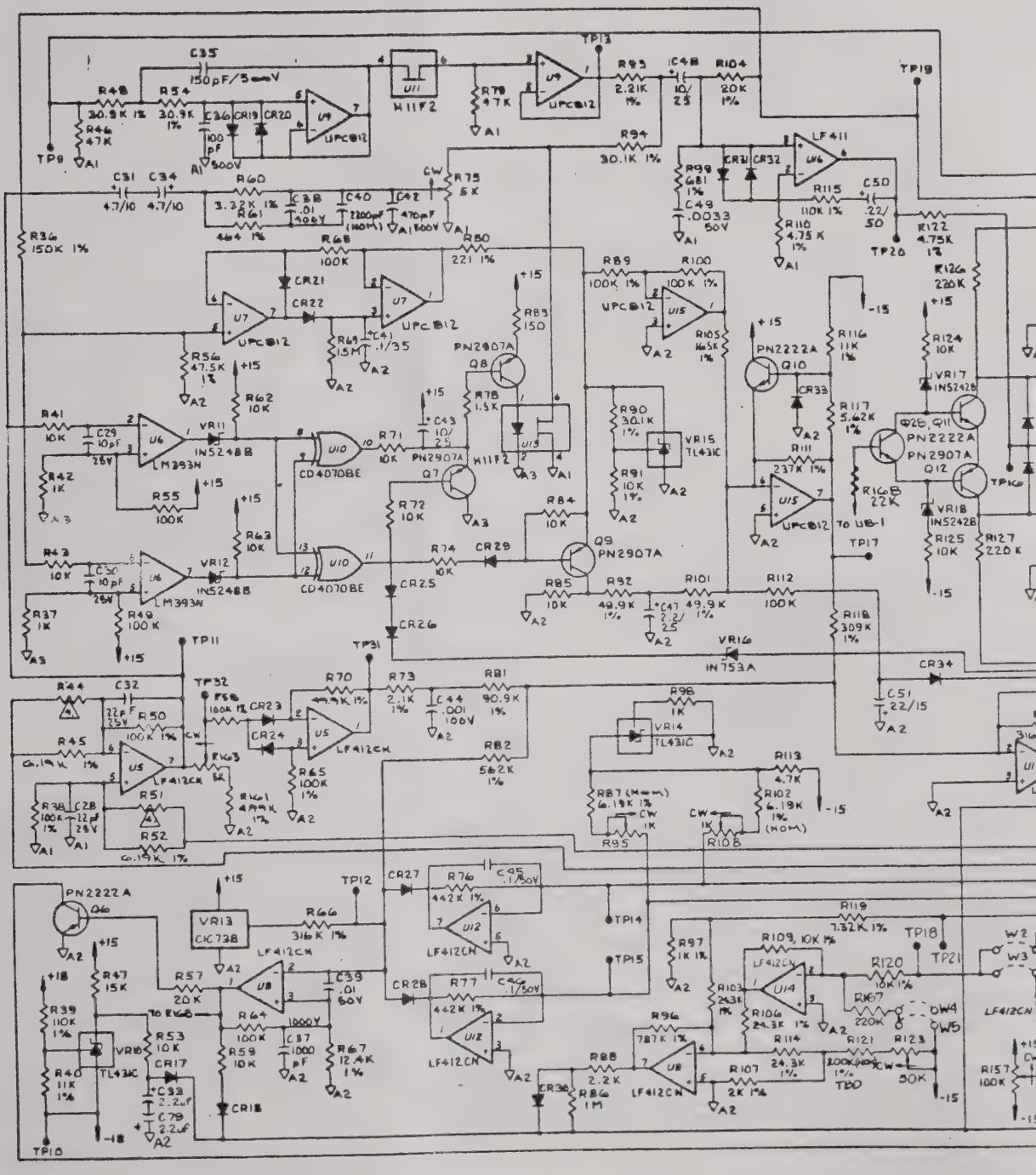
			ADDITIONAL APPROVALS
RELEASE	R Erskine	9/23/87	
PROJ ENG	J Rouse	9-21-87	
CHECK	ERWINE	9/87	
DESIGN			
DRAFT	BEACH	9-8-87	

California Instruments
A DIVISION OF ANSTAR TECHNICAL PRODUCTS CO., INC.
SAN DIEGO CALIFORNIA

CONTRACT

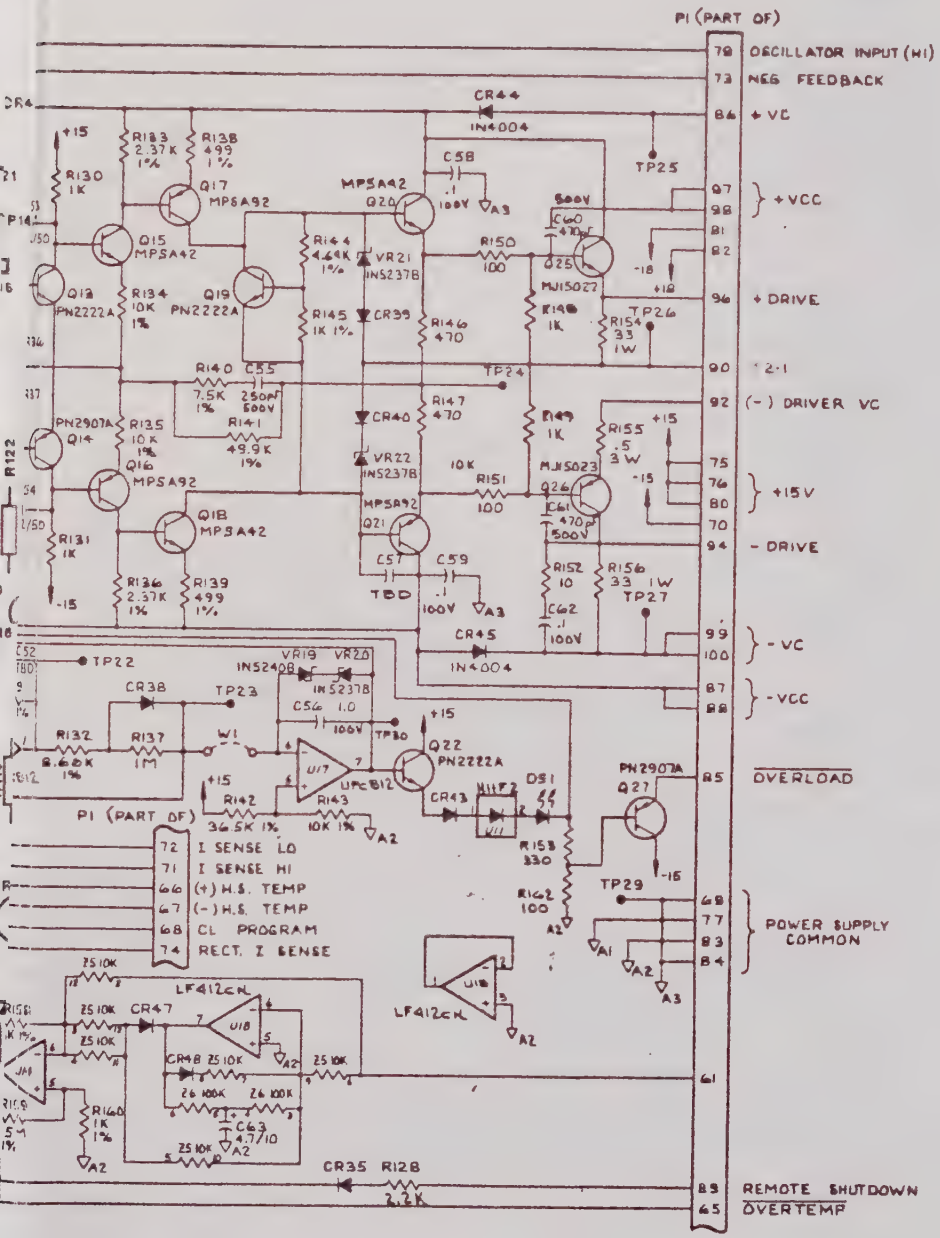
CODE IDENT 16067

DWG NO. 4000-093 REV E



NOTES (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	REVISED CIRCUITRY	4/87	J. Rouse
B	REVISED Q20, Q21, C57	7/87	J Rouse
C	ADD C79	8/87	J. Rouse
D	R49 WAS TO -15V NOW +15V	9/87	J. Rouse
E	ADDED Q28 AND R168	4/88	J Rouse



ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REQD PER ASSY					

LIST OF MATERIAL

DIM IN INCHES TOLERANCES: XXX ± .010, XX ± .03, X° ± 30
BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓
DWG SIZE D

TITLE: SCHEMATIC, PREAMPLIFIER

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FINISH

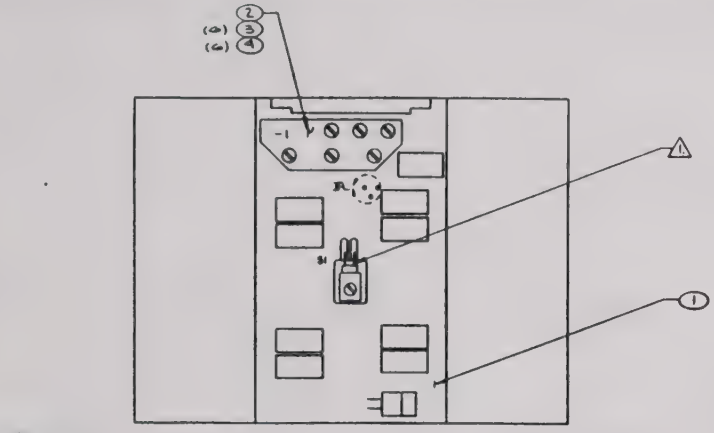
RELEASE	R Eskuri	4-21-87	ADDITIONAL APPROVALS
PROJ ENG	J. Rouse	4-U-87	
CHECK	Ewing	4-13-87	
DESIGN			
DRAFT	D.M. Ewing	4-13-87	

California Instruments
A DIVISION OF AMBER TECHNICAL PRODUCTS CO. INC.
SAN DIEGO, CALIFORNIA

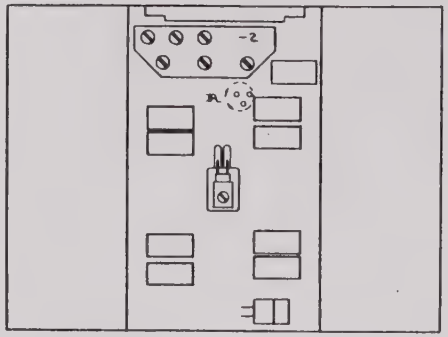
CONTRACT NO
CODE IDENT 16067
DWG NO 4000-[illegible]3
REV E
SCALE
SHEET 2 OF 2

QTY REQD	USED ON	NEXT ASSY

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ADDED INSULATOR & H.S. COMPOUND	7/14/72	[illegible]
B	REVISED W1 FROM 16GA TO 16GA	4/73	[illegible]
C	REVISED PARTS LIST	4/80	[illegible]
D	REVISED HEATSINK BRACKET	4/84	[illegible]



POSITIVE OUTPUT
-1 ASSEMBLY



NEGATIVE OUTPUT
-2 & -3 ASSEMBLIES
(SAME AS -1 EXCEPT AS SHOWN)

DETAIL A
SCALE 2/1

DETAIL B
SCALE 2/1

FOR PARTS LIST SEE 4000-401-1; -2; -3

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
1	1	2	13a1XP		4000-405	
	1	1	971XP		4000-410	
1	1		651XP		4000-411	
-3	-2	-1	USED ON		NEXT ASSY	
QTY REQD						

LIST OF MATERIAL

DIM IN INCHES TOLERANCES .XX ± .010 .XXX ± .003 ∠° ± 30' | BREAK ALL SHARP CORNERS & EDGES | MACH SURFACES ~~~ | DWG SIZE D

TITLE: HEATSINK ASSEMBLY, POWER AMPLIFIER

ENG. MANAGER	[illegible]	4/10/75	ADDITIONAL APPROVALS
PROJ. ENGR.	J. ROWE	12-2-05	
CHECK	A. ROBERTS	4/10/72	
DESIGN			
DRAFT	STANIARSKI	11/27/64	

California Instruments
A DIVISION OF MISTRAS TECHNICAL PRODUCTS CO. INC
SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO 4000-401 | REV D | SCALE 1/1 | SHEET 1 OF 1

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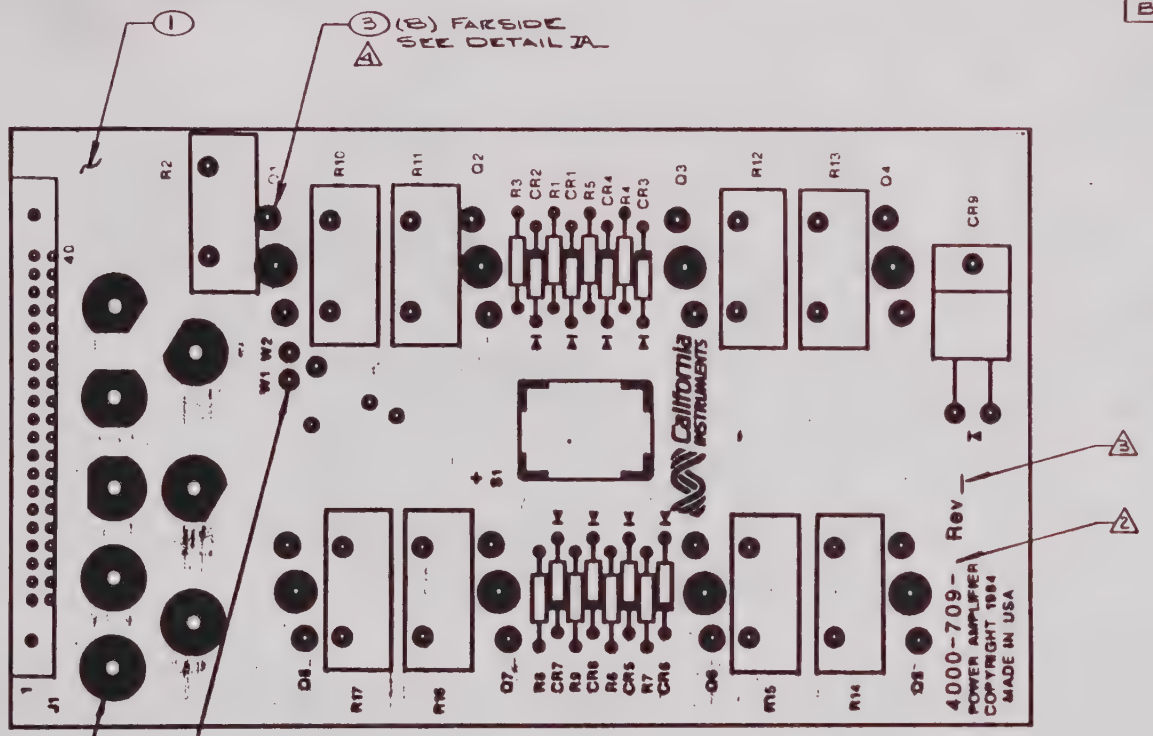
FINISH: ———

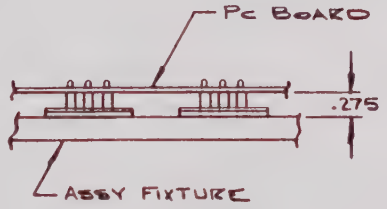
⚠ BREAK OFF MIDDLE LEAD BEFORE SOLDERING TO PADS.

NOTES (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	REVISED & REDRAWN	5/86	J. Rouse DJH
B	REVISED PARTS LIST	1/87	J. Rouse



PWB REV "A" SHOWN



DETAIL IA
SCALE = 1/1

FOR PARTS LIST SEE 4000-709-1

4. USE ASSY FIXTURE SK253 FOR INSTALLATION OF SOCKETS.
3. MARK WITH APPROPRIATE REV LTR.
2. MARK WITH APPROPRIATE DASH NO.
1. FOR SCHEMATIC SEE 4000-083

NOTES: (UNL... OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO.	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
1		1801XP		4000-401		
1		971XP		4000-401		
1		661XP		4000-401		
-1		USED ON		NEXT ASSY		

LIST OF MATERIAL

DIM IN INCHES TOLERANCES .XXX ± .010 .XX ± .03 X° ± 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES
DWG SIZE C

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FINISH

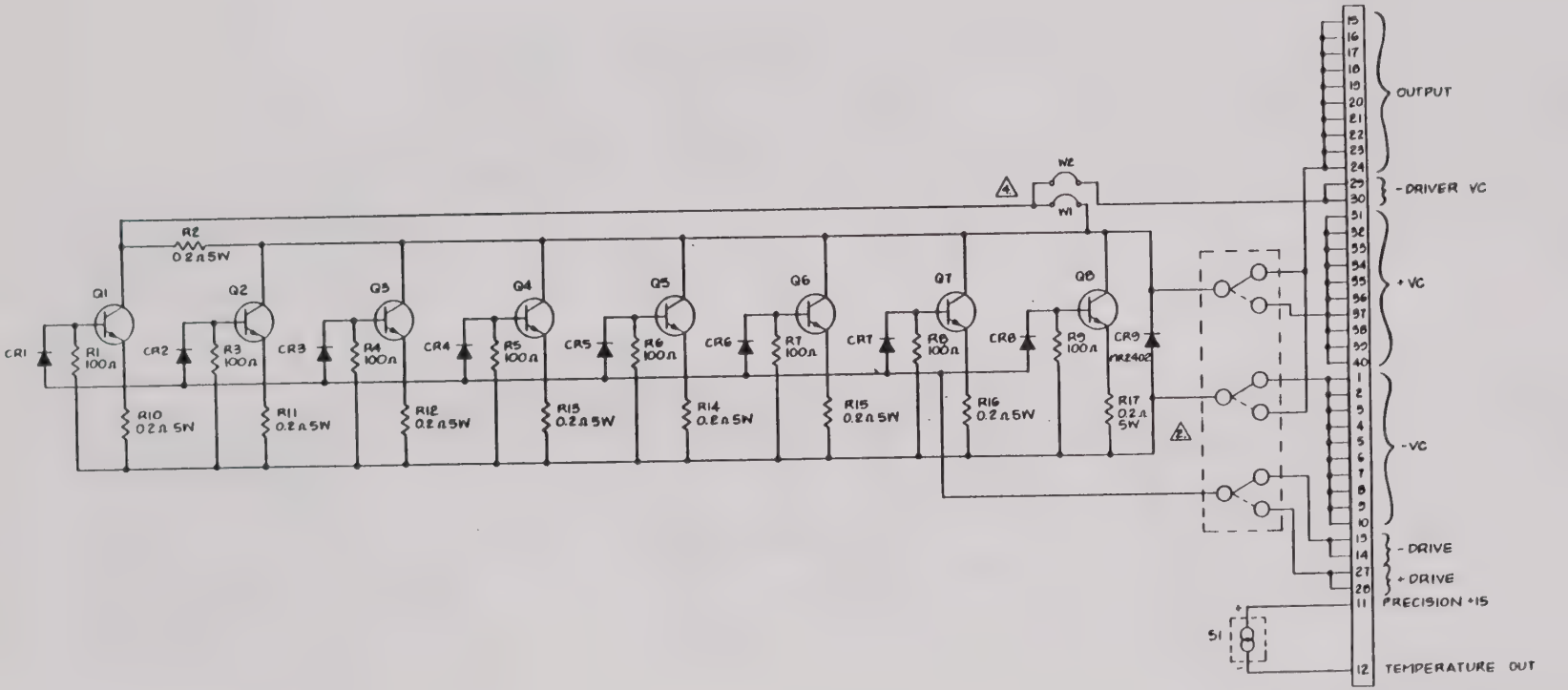
TITLE
PRINTED CIRCUIT ASSY
POWER AMPLIFIER

			ADDITIONAL APPROVALS
RELEASE	R. Rehmark	6/26/86	
PROJ ENG	J. ROUSE	6-24-86	
CHECK	EEWINE	6-24-86	
DESIGN			
DRAFT	DM EWINE	6/24/86	

California INSTRUMENTS
A DIVISION OF AMBTAR TECHNICAL PRODUCTS CO. INC SAN DIEGO, CALIFORNIA

CONTRACT NO.
CODE IDENT 16067
DRAWING 4000-709
REV B
SCALE 2/1
SHEET 1 OF 1

4000-709 B



REVISIONS

REV	DESCRIPTION	DATE	APPROVED

⚠4 W1 USED ON 4000-401-1 & -2, W2 USED ON 4000-401-3 ONLY.
2 ALL TRANSISTORS ARE MJ15022
⚠3 SOLID LINE CONNECTIONS DENOTE NEGATIVE OUTPUT (4000-401-2 & -3). DASHED LINE CONNECTIONS DENOTE POSITIVE OUTPUT (4000-401-1).
1 ALL DIODES ARE IN4004.

NOTES: (UNLESS OTHERWISE SPECIFIED)

QTY REQD	USED ON	NEXT ASSY
	1301XP	4000-709
	971XP	4000-705
-REF-	651XP	4000-709

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REQD PER ASSY		LIST OF MATERIAL			

DIMS IN INCHES TOLERANCES XXX ± .010 XX ± .03 X° ± 30' — BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓ — DWG SIZE D

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH

TITLE: SCHEMATIC DIAGRAM, POWER AMP

RELEASE	R Edquist	11/1/71	ADDITIONAL APPROVALS
PROJ ENG	J. ROUSE	5 2285	
CHECK	E E Wilke	11/1/71	
DESIGN			
DRAFT	SKAMARSKI	8/6/71	11/1/71

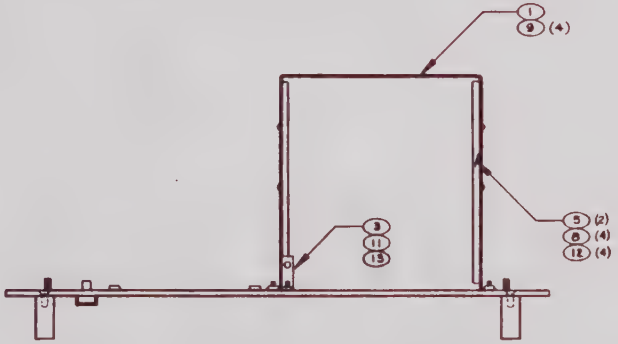
California Instruments — A DIVISION OF MARK CONTROL CORPORATION — SAN DIEGO, CALIFORNIA

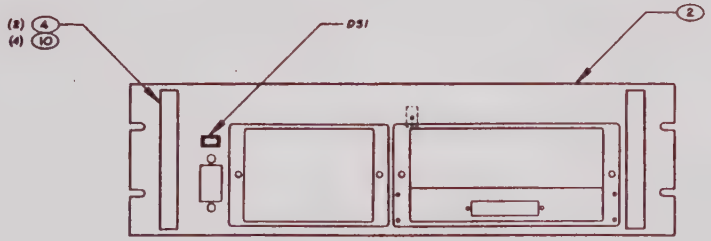
CONTRACT NO | CODE IDENT 16029

DWG NO 4000-083

SCALE NONE | SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	DISCONTINUE FOR 931XP USE AJB		
B	REVISED CARD GUIDES		
C	REVISED OSC BRKT MTG		
D	REVISED CIRCUIT BREAKER -2 ASSY ONLY		
E	REVISED CARD GUIDES		





FOR PARTS SEE 4000-408-1, -2

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
		-2 FRONT PANEL ASSY			
		-1 FRONT PANEL ASSY			

REQD PER ASSY

LIST OF MATERIAL

DIM IN INCHES TOLERANCES XXX ± .010 XX ± .03 X° ± 30

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES

DWG SIZE D

TITLE FRONT PANEL ASSY

California Instruments — A DIVISION OF MARTIN TECHNICAL PRODUCTS CO INC SAN DIEGO CALIFORNIA

RELEASE R Hedgcock 3/22/85

PROJ ENG J ROUSE 3-22-85

CHECK

SCALE

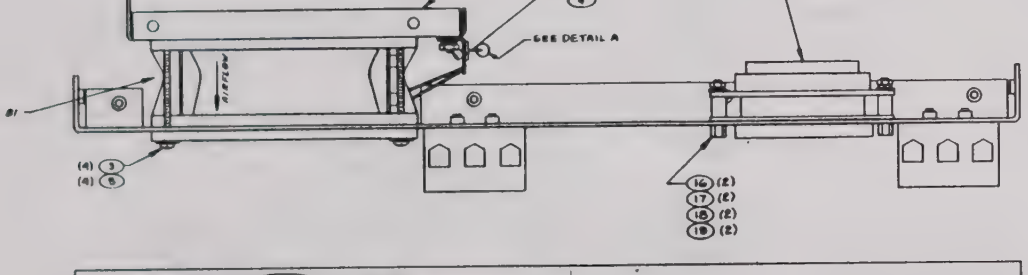
CONTRACT NO

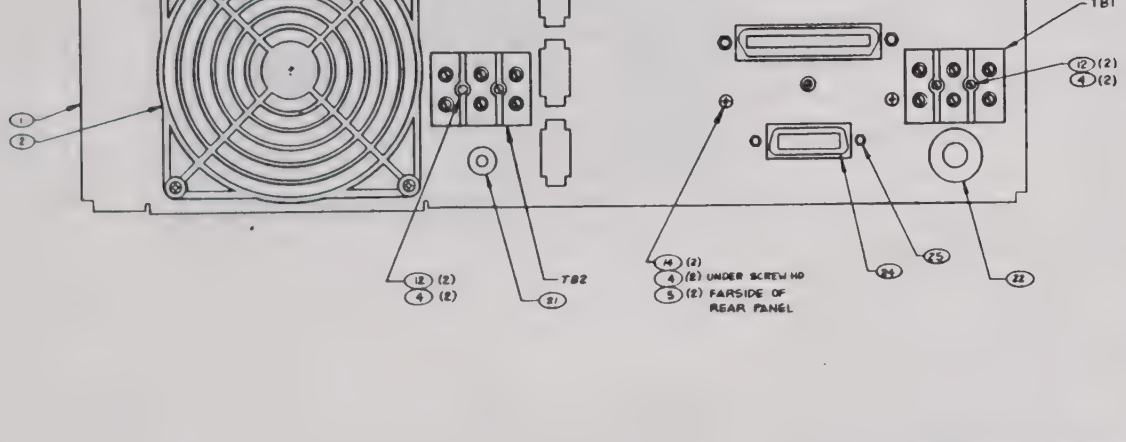
CODE IDENT 16067

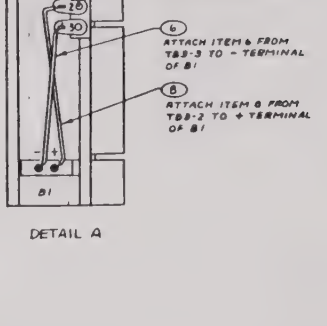
SIZE

1	631XP	4000-411	
1	821XP	4000-412	

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	DISCONTINUE USING THIS ASSY FOR 93/XP ONLY. A/R		
B	FRONT VIEW OF #20 REDRAWN, 7 SCREWS ADDED #15, RG #23 ADDED WITH SECTION A-A'.		
C	ITEM 9 REDRAWN. REMOVED COVER GUIDES A/R		
D	TB3 MOUNTING CHNG, WIRES TO B1 ADDED		







DETAIL A

FOR PARTS LIST SEE 4000-407-1

ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

QTY REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
1		82IXP	4000-412			
1		65IXP	4000-411			
-1		USED ON	NEXT ASSY			

DIM IN INCHES TOLERANCES .XX ± .010 .XX ± .03 .X ± .1 | BREAK ALL SHARP CORNERS & EDGES MACH SURFACES | DWG SIZE D

TITLE: REAR PANEL ASSY

FINISH: —

PROJ ENG	A Richard	3/6/85
PROJ ENG	J ROUSE	3/22/85
CHECK	A J ROBERTO	3/26/85
DESIGN		
DRAFT	RICE	11/17/84

ADDITIONAL APPROVALS: ENGINEERING

California Instruments
A DIVISION OF
MISSION TECHNICAL PRODUCTS CO.
SAN DIEGO, CALIFORNIA

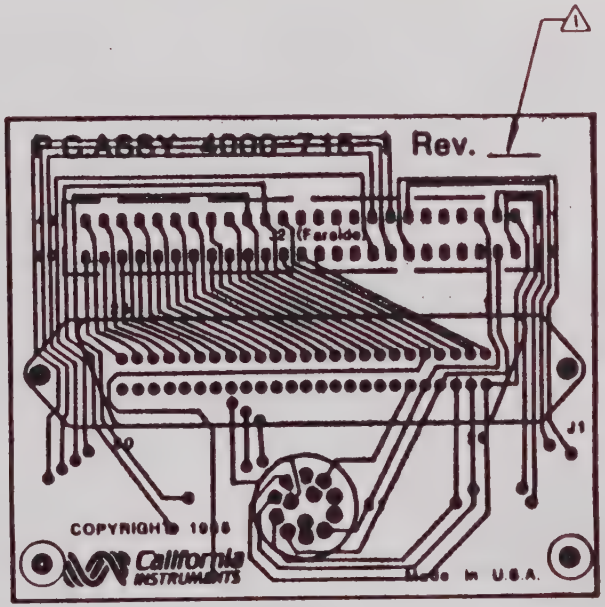
CONTRACT NO: 1600

DWG NO: 4000-407 D

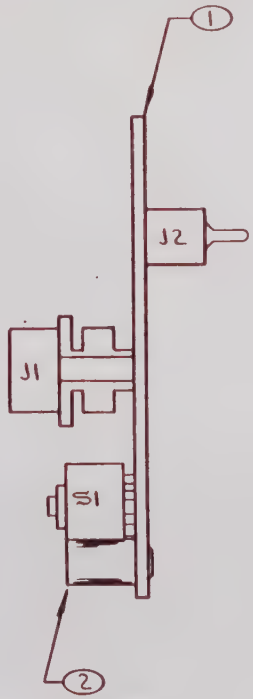
SCALE: 1:1 SHEET 1 OF 1

NOTES (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
C	REVISED & REDRAWN	8/5/85	J. Rouse 8-5-85



PRINTED WIRING BOARD
REV "D" SHOWN



(2 REQD)

FOR PARTS LIST SEE PL 4000-715-1

REQD PER ASSY	ITEM NO.	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT.	NOTE NO
1		1301XP				4000-906-1
1		971XP				4000-929-1
1		651XP				4000-907-1
1		321XP				4000-907-1
-1		USED ON		NEXT ASSY		

LIST OF MATERIAL

. FOR SCHEMATIC SEE 4000-080

) PERMANENTLY MARK ASSY REV LTR WHERE SHOWN.

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES
TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH

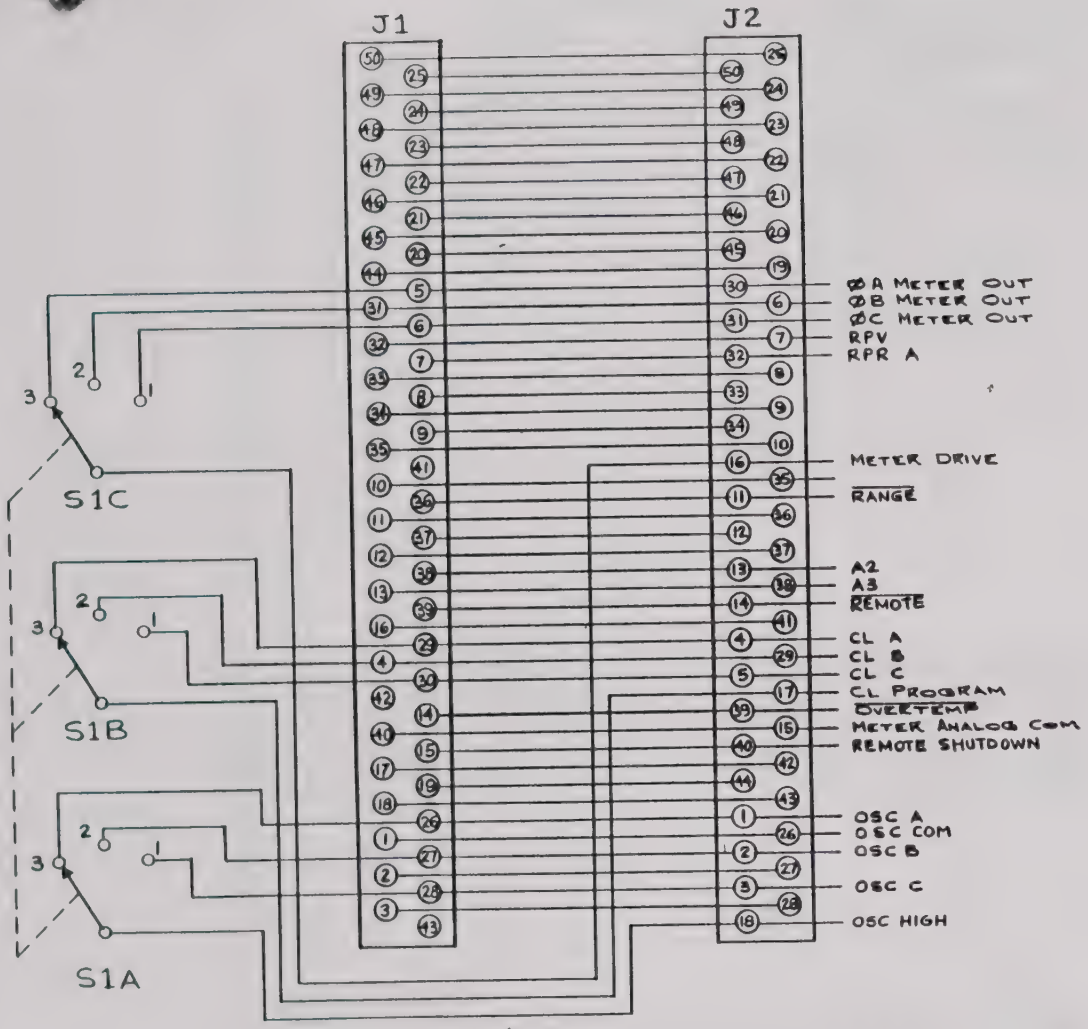
TITLE
PRINTED CIRCUIT ASSY,
PHASE SELECTOR SWITCH

			ADDITIONAL APPROVALS
RELEASE	R. Lidyard	8/6/85	
PROJ ENG	J. Rouse	8/5/85	
CHECK	ERWINE	8/5/85	
DESIGN			
DRAFT			

California INSTRUMENTS
A DIVISION OF AMBTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO
CODE IDENT 16067
4000-715 REV C
SCALE 2/1 SHEET 1 OF 1

REV	DESCRIPTION	DATE	APPROVED
A	REVERSE PINS 1 & 3 ON S1 SECTIONS A & B. J1 CORRECTED.	7/9/85	BK



ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO	REQD PER ASSY

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY
	1301XP	4000-715-1
	971XP	4000-715-1
	651XP	4000-715-1
	321XP	4000-715-1

NOTES (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES TOLERANCES XXX ± .010 XX ± .03 X° ± 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE C

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FINISH ———

TITLE

SCHEMATIC, PHASE SELECTOR SWITCH

			ADDITIONAL APPROVALS		
RELEASE	R. Sedgwick	3/25/85			
PROJ ENG	J. ROUSE	3-22-85			
CHECK	A. ROBERTO	3/28/85	ERWINE	7/9/85	
DESIGN					
DRAFT	C DELPINO	11/26/84		3/85	

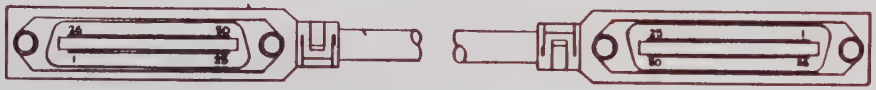
California Instruments
A DIVISION OF AMSTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

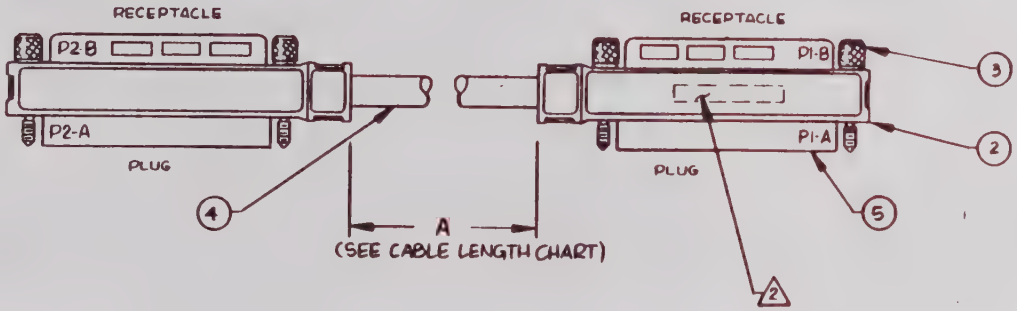
CONTRACT NO | CODE IDENT 16067

DWG NO 4000-086 | REV A

SCALE NONE | SHEET 1 OF 1

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ADD TOP VIEW, SHEET 2, CHANGE PL.	9/85	





CABLE LENGTH	
ASSY	A DIM
-1	80"

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
2	5	552772-1	PLUG/RECEPTACLE	AMP	00779	
1	4	9546	24GA STRANDED COND	BELDEN	70903	
4	3	4000-279-1	JACK SCREWS		16067	
2	2	552773-1	STRAIN RELIEF CVR	AMP	00779	
1		-1	CABLE ASSY			

LIST OF MATERIAL

XP SERIES	USED ON	NEXT ASSY
QTY REQD		

DIM IN INCHES TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH —

TITLE
CABLE ASSY
SYSTEM INTERFACE

			ADDITIONAL APPROVALS
RELEASE	R Bedgood	9/12/85	
PROJ ENG	J. ROUSE	5/1/85	
CHECK	EEWINE	9/1/85	
DESIGN			

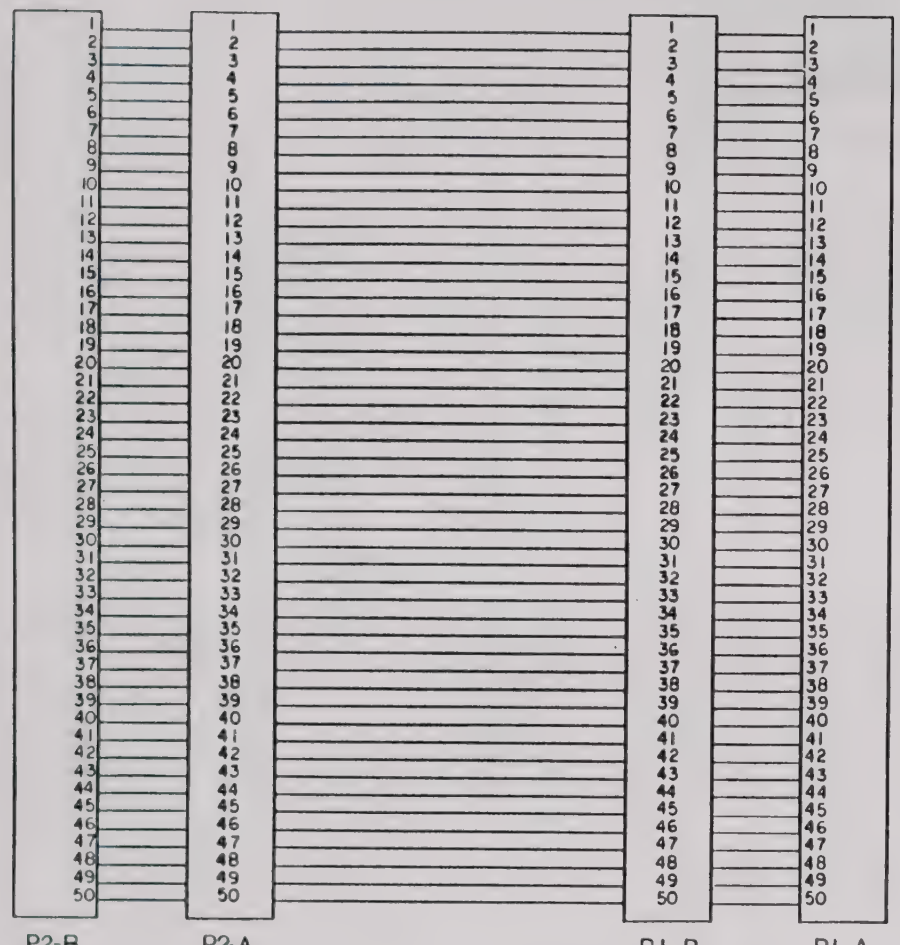
California Instruments
A DIVISION OF AMBAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO
CODE IDENT 16067
4000-427 REV A

△ MARK WITH PART NO.
FOR SCHEMATIC SEE SHEET 2.
NOTES: (UNL[illegible]THERWISE SPECIFIED)

4000-427 A

REV	DESCRIPTION	DATE	APPROVED
A	SHEET 2 ADDED	5/85	



REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

DIM IN INCHES
TOLERANCES
XXX ± .010
XX ± .03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES
$-\sqrt{}$

DWG SIZE C

TITLE
SCHEMATIC, SYSTEM INTERFACE

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH —

			ADDITIONAL APPROVALS
RELEASE	B Eckard	5/21/85	
PROJ ENG	J. Rouse	5/20/85	
CHECK	ERWINE	5/29/85	
DESIGN			
DRAFT	RICE	5/21/85	

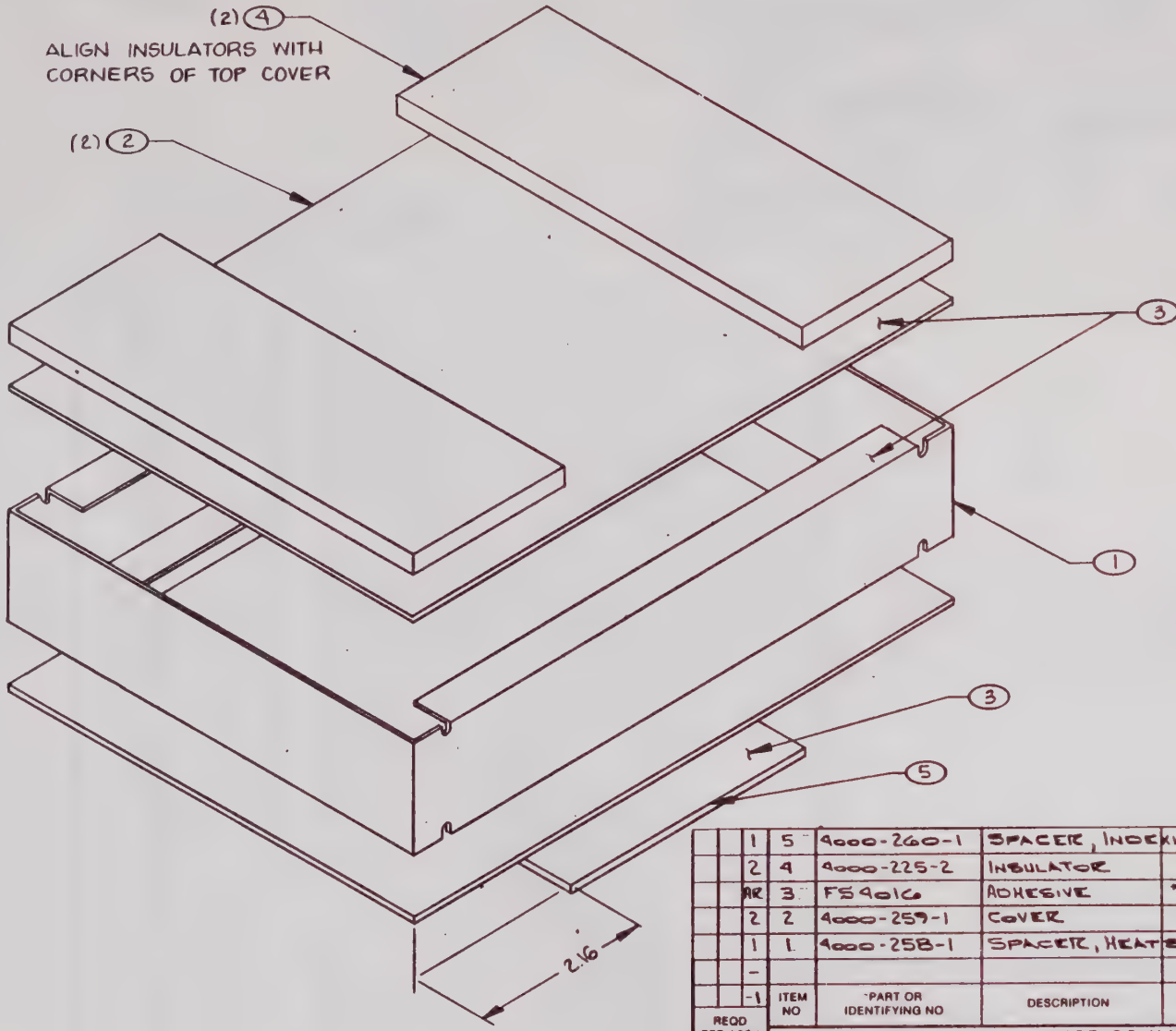
California INSTRUMENTS
A DIVISION OF AMBAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO
CODE IDENT 16067
DWG NO 4000-427
REV A
SCALE NONE
SHEET 2 OF 2

QTY REQD	USED ON	NEXT ASSY
	XP SERIES	

NOTES (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED



REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
1	5	4000-260-1	SPACER, INDEXING		16067	
2	4	4000-225-2	INSULATOR		16067	
AR	3	FS9016	ADHESIVE	#3B050 (BLACK MAX)	05972	
2	2	4000-259-1	COVER		16067	
1	1	4000-258-1	SPACER, HEATSINK		16067	
-						
-1						

LIST OF MATERIAL

-1	USED ON	NEXT ASSY
1	651XP	4000-411
2	321XP	4000-412

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES
TOLERANCES
XXX ± 010
XX ± 03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES √

DWG SIZE C

FINISH —

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

TITLE
HEATSINK SPACER ASSEMBLY

			ADDITIONAL APPROVALS	
RELEASE	R Bedyard	1/25/85		
PROJ ENG	J ROUSE	3-22-85		
CHECK	AJ ROBERTO	01/FEB 86	ERWIN	3/6/85
DESIGN				
DRAFT	STAWIARSKI	11/7/84		2/5/85

California Instruments
A DIVISION OF AMBTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO | CODE IDENT 16067

DWG NO 4000-408 | REV

SCALE 1/1 | SHEET 1 OF 1

4000-408

D C B A

SECTION VII

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and a complete list of replaceable parts. The parts are listed by their major assembly in alpha-numeric order by their reference designators. The list includes the parts description, manufacturers' identification (see Appendix A for list of manufacturers), and California Instruments' part numbers.

7.2 ORDERING INFORMATION

In order to ensure prompt, accurate service, please provide the following information, when applicable, for each replacement part ordered.

a. Model number and serial number of the instrument.

b. California Instruments part number for the sub-assembly where component is located (PARENT ITEM NO.).

c. Component reference designator (SEQ NO.).

d. Component description (DESCRIPTION TRUNCATED).

e. Component manufacturer's FSCM number (VENDOR).

f. California Instruments part number (COMPONENT ITEM NO.).

A further explanation of these terms can be found in Section 7.3.

All replacement part orders should be addressed to:

California Instruments
Attention: Parts Department
9025 Balboa Avenue
San Diego, California 92123-1509

7.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

7.3.1 "SEQ NO." - Sequence Number: the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alpha-numeric order.

7.3.2 "COMPONENT ITEM NO." - This is California Instruments' part number. Please use this number when ordering spares or replacements.

7.3.3 "DESCRIPTION TRUNCATED" - A brief description of the item. The abbreviations are per MIL-STD-12 or industry accepted standards.

7.3.4 "ENGINEERING DRAWING NUMBER" - This is used for one of the following:

a. The document/specification number generated by California Instruments to control the part.

b. The generic part number (military specifications or industry accepted standard).

c. The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown. (Contact California Instruments if the full number is required.)

7.3.5 "VENDOR" - This is the FSCM code to identify the manufacturer. (See Appendix A).

7.3.6 "QTY" - This is the Quantity and Unit of Measure used in the assembly. The Unit of Measure abbreviations are per MIL-STD-12 or industry accepted standard.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
	4000-050-0	HARNESS ASSY,JUMPER	4000-050 REV K	16067	1.0	EA
	4000-050-2	HARNESS ASSY	4000-050 REV K	16067	1.0	EA
	4000-050-6	HARNESS ASSY	4000-050 REV K	16067	1.0	EA
	4000-961	MANUAL,651XP	MANUAL REV D	16067	1.0	EA
A1	4000-714-1	PC ASSY,MOTHER BOARD	4000-714 REV G	16067	1.0	EA
A2	4000-700-2	PC ASSY,FILTER	4000-700 REV C	16067	1.0	EA
A3	4000-724-2	PC ASSY,PREAMP	4000-724 REV G	16067	1.0	EA
A4	4000-401-1	HEATSINK ASSY,PWR AMP	4000-401 REV D	16067	1.0	EA
A6	4000-401-3	HEATSINK ASSY,PWR AMP	4000-401 REV D	16067	1.0	EA
CB1	270128	CIRCUIT BREAKER,30A,250V0	UPGX-66-1-65-3*	81541	1.0	EA
C1	610881	CAP,MYLAR,.22UF,250V SB	713A1GG224PK251	80031	1.0	EA
C2	610929	CAP,MYLAR,.01UF,400V	712A1BB103PK40*	80031	1.0	EA
C3	610929	CAP,MYLAR,.01UF,400V	712A1BB103PK40*	80031	1.0	EA
C4	611137	CAP,PP,10UF,135VAC	935B1C106	14752	1.0	EA
K1	245182	RELAY,POWER,2C,30A,24VDC	21CPX-3 24VDC	94696	1.0	EA
L1	4000-011-1	INDUCTOR,.5MH,15A,E100	4000-011-1	16067	1.0	EA
R1	550189	RES,PWR,50W,.01 OHM,1%	RH-50-73-.01	91637	1.0	EA
R2	550008	RES,PWR,3W,5.1 OHM,1%	RS-2B-5.1 OHM	91637	1.0	EA
R3	FS7000	RES,CARB,1/4W,TBD	RC07GF...	81349	1.0	EA
R4	550278	RES,PWR,40W,150 OHM 5%	F40J150	44655	1.0	EA
R5	550278	RES,PWR,40W,150 OHM 5%	F40J150	44655	1.0	EA
R7	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R8	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R9	550279	RES,PWR,40W,250 OHM 5%	F40J250	44655	1.0	EA
R12	540071	RES,CARB,1W,4.7M OHM	RC32GF475J	81349	1.0	EA
R13	540071	RES,CARB,1W,4.7M OHM	RC32GF475J	81349	1.0	EA
R14	540071	RES,CARB,1W,4.7M OHM	RC32GF475J	81349	1.0	EA
TB4	250086	TERMINAL STRP, 6TERM,1MT	901	83330	1.0	EA
T1	4000-015-1	TRANSFORMER,INPUT	4000-015 REV D	16067	1.0	EA
T2	4000-014-2	TRANSFORMER,OUTPUT,5KHZ	4000-014-REV B	16067	1.0	EA
T3	CIC604-2	CUR TRANS BURDEN RES ASSY	CIC604-2 REV 0	16067	1.0	EA
1	FS1029	SCREW,FLH,S/S,6-32X3/8	MS24693-C26	96906	24.0	EA
2	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	15.0	EA
3	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	6.0	EA
4	FS1050	SCREW,FLH,S/S,8-32X7/16	MS24693-C49	81349	4.0	EA
5	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	7.0	EA
6	FS1065	NUT,HEX,S/S,8-32	MS35649-284	96906	11.0	EA
7	FS1086	NUT,HEX,S/S,4-40X3/16	4-40X3/16	81349	2.0	EA
8	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	11.0	EA
9	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	2.0	EA
10	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	27.0	EA
11	FS1074	WASHER,SPLT,S/S,#8	MS35338-137	96906	17.0	EA
12	FS1075	WASHER,SPLT,S/S,#10	MS35338-138	96906	11.0	EA
13	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	9.0	EA
14	FS1081	WASHER,FLAT,S/S,#8	MS15795-841	96906	9.0	EA
15	FS1147	WASHER,FLAT,1/4	MS15795-810	96906	8.0	EA
16	FS1167	NUT,HEX,S/S,1/4-20	MS35649-2254	96906	8.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
17	FS1173	WASHER,SPLT,1/4	MS35338-139	96906	15.0	EA
18	210892	STANDOFF,8-32 X 1 1/16	8162-N-0832	06540	1.0	EA
19	210787	STANDOFF,M/F,8-32X3-1/2"	AL6982-3.500-22	05791	1.0	EA
20	210816	SPACER, #8 X 7/8,ALUM	9234-A-171	06540	2.0	EA
22	330337	THYR,SCR,25A,800V	TT25N800KOC	24972	1.0	EA
27	4000-225-3	INSULATOR,HEATSINK,.250	4000-225-3	16067	2.0	EA
30	4000-226-1	COVER,SHROUD,4" FAN	4000-226	16067	1.0	EA
32	4000-403-2	FRONT PANEL ASSY	4000-403 REV F	16067	1.0	EA
34	4000-285-1	COVER,SIDE,SHROUD	4000-285-1	16067	1.0	EA
38	4000-407-1	REAR PANEL ASSY	4000-407 REV E	16067	1.0	EA
42	FS4001	THERMAL COMPOUND	351	13103	1.0	OZ
44	FS4016	ADHESIVE/SEALANT,LOCTITE	38050	05972	.0	OZ
47	4000-249-1	COVER,CHASSIS	4000-249-1	16067	1.0	EA
48	4000-408-1	HEATSINK SPACER ASSY	4000-408 REV 0	16067	1.0	EA
51	4000-263-1	BRACKET,MTG,TORUS	4000-263	16067	1.0	EA
52	FS1158	SCREW,PNH,S/S,6-32X1-1/4	MS51957-35	96906	1.0	EA
53	210309	BUMPER,RUBBER	2193	08065	1.0	EA
54	FS1043	SCREW,FLH,S/S,8-32X3/8	MS24693-C48	81349	2.0	EA
55	4000-241-1	CHASSIS	4000-241	16067	1.0	EA
56	FS1165	BOLT,HEX,S/S,1/4-20X1/2	MS35307-303	96906	7.0	EA
57	4000-236-1	BRACKET,REAR SUPPORT	4000-236	16067	1.0	EA
58	4000-426-1	HARNESS ASSY,JUMPER	4000-426	16067	2.0	EA
59	FS1099	WASHER,FLAT,FIBRE,#8X.44	2259-F171	06540	2.0	EA
60	FS1100	NUT,HEX,BRASS,8-32	4138B116	33855	4.0	EA
61	FS1103	WASHER,FLAT,S/S,#6X.310D	MS15795-805	81349	6.0	EA
65	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	12.0	EA
66	4000-252-1	COVER,TERM BD W/4000-252	4000-252	16067	1.0	EA
67	250419	TERM STRAP,COPPER	4805-16-3	86928	5.0	EA
68	FS1041	SCREW,PNH,S/S,8-32X5/16	MS59157-42	81349	13.0	EA
69	FS3001	GROMMET,STRIP,.085	CSG-09-BLACK	95987	12.0	IN
70	210841	BUMPER,RUBBER	5200-01-03-5053	02768	4.0	EA
71	FS1062	SCREW,PNH,S/S,10-32X3/4	MS51958-65	96906	4.0	EA
73	FS1135	SCREW,PNH,S/S,8-32X1-1/2	MS51957-51	81349	2.0	EA
74	250359	LUG,RING,SOLDER,#6	809	79963	4.0	EA
75	FS6003	TUBING,SHRINK,1/4	CP221-1/4-BLK	24011	4.0	IN
76	FS4005	NOMEX,.010 THK,NATURAL	NOMEX,.010 THK	81349	336.0	SI
77	FS4004	ADHESIVE,SPRAY	77	04963	.5	OZ
78	FS6003	TUBING,SHRINK,1/4	CP221-1/4-BLK	24011	22.0	IN
79	4995-146-1	DECAL,SCREW PENETRATION	4995-146-1	16067	1.0	EA
81	FS1013	SCREW,PNH,S/S,4-40X3/8	MS51957-15	96906	4.0	EA
82	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	4.0	EA
83	FS1079	WASHER,FLAT,S/S,#4	MS15795-804	96906	4.0	EA
84	FS1071	WASHER,INTER,S/S,#10	MS35333-73	96906	3.0	EA
85	FS1104	BOLT,HEX,BRS,10-32X1/2	10-32X1/2	81349	3.0	EA
87	4000-293-1	PLATE,MTG,RESISTOR	4000-293-1	16067	1.0	EA
88	4000-228-1	BRACKET,PLUG-IN,OSC	4000-228-1	16067	1.0	EA
89	210912	GUIDE,PWB,5.65	33-9016-12-01-*	91662	2.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
90	FS1024	SCREW,PNH,S/S,6-32X3/16	MS51957-25	96906	4.0	EA
91	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	4.0	EA
92	FS1168	BOLT,HEX,S/S,10-32X3/8	10-32X3/8	81349	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	FS2028	LUG,RING,CRIMP,8-8	R3503BF	14726	4.0	EA
2	FS2013	LUG,RING,CRIMP,8-1/4	R3032BF	14726	6.0	EA
3	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	1.0	EA
4	FS2020	LUG,RING,CRIMP,22/18-1/4	5114	83330	3.0	EA
5	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	5.0	EA
6	FS2024	LUG,RING,CRIMP,12/10-1/4	R4171F	14726	1.0	EA

PARENT ITEM NO.
4000-050-1

HARNESS ASSY
ENGR DRAW NO. 4000-050 REV K

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	410293	TERMINAL,CRIMP	08-56-0105	27264	23.0	EA
2	410407	CONN,PC HSG,9 PIN	09-50-3091	27264	1.0	EA
3	410351	CONN,PC HSG,16 PIN	09-50-3161	27264	1.0	EA
4	FS2028	LUG,RING,CRIMP,8-8	R3503BF	14726	2.0	EA
5	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
3	410293	TERMINAL,CRIMP	08-56-0105	27264	2.0	EA
5	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	6.0	EA
6	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	1.0	EA
7	FS2032	LUG,S/0,F,CRMP,22/18-187	S09619SF	14726	2.0	EA
9	4000-248-1	BRKT,TERM BD,AC VOLT SEL	4000-248-1	16067	1.0	EA
10	4000-251-1	TERM BD,V SEL W/4000-251	4000-251	16067	1.0	EA
12	210790	STANDOFF,M/F,6-32X5/8	9797-SS-0632	06540	4.0	EA
13	210086	STANDOFF,6-32 X 3/8"	1551D-11	88245	4.0	EA
14	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	4.0	EA
15	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	4.0	EA
16	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
XK1	245183	SOCKET,RELAY 8 CONTACT	S-2408-AB	94696	1.0	EA
1	FS6014	TUBING,TEFLON,AWG 12	TFT-200-12-NAT.	92194	1.2	IN
2	FS2029	LUG,RING,CRIMP,12/10-8	R4189F	14726	1.0	EA
3	FS2020	LUG,RING,CRIMP,22/18-1/4	5114	83330	1.0	EA
4	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	U
CR1	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR2	310210	DIODE,ZNR,27V,.5W,10%	1N5254A	04713	1.0	E
CR3	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
C1	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	E
C2	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	E
C3	611091	CAP,CER,22PF,25V	CN15C220J	71590	1.0	E
C4	611091	CAP,CER,22PF,25V	CN15C220J	71590	1.0	E
C5	610821	CAP,CER,.1UF,500V	5HK-P10	56289	1.0	E
J1	410396	CONN,PC RCPT,100 PIN	RCR50-6142-15	57856	1.0	E
J7	410411	CONN,PC HDR,9 PIN	26-48-2095	27264	1.0	E
J10	410401	CONN,PC RCPT,40 PIN	RC20-4242-5	57856	1.0	E
J11	410401	CONN,PC RCPT,40 PIN	RC20-4242-5	57856	1.0	E
J12	410402	CONN,PC HDR,4 PIN,900	22-12-2044	27264	1.0	E
Q1	330321	TRANSISTOR,PWR,PNP,TO220A	TIP32C	04713	1.0	E
R1	550259	RES,PWR,10W,330 OHM,5%	40J330	44655	1.0	E
R2	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	E
R3	570144	POT,MT,PC,100 OHM,1/4W	ET34P101	30983	1.0	E
R4	560863	RES,FILM,1/8W,49.9 OHM1%	RN55C49R9F	81349	1.0	E
R5	CIC522	RES,PREC,CIC522	CIC522	16067	1.0	E
R6	CIC522	RES,PREC,CIC522	CIC522	16067	1.0	E
R9	520057	RES,CARB,1/2W,10K OHM	RC20GF103J	81349	1.0	E
U1	360217	IC,OP-AMP,FET,GP	LF356N	27014	1.0	E
W1	250396	JUMPER BLOCK	90059-0009	27264	1.0	E
W2	250396	JUMPER BLOCK	90059-0009	27264	1.0	E
W3	250396	JUMPER BLOCK	90059-0009	27264	1.0	E
W4	250396	JUMPER BLOCK	90059-0009	27264	1.0	E
W5	FS5119	WIRE,BUS,AWG 22,QQ-W-343E	QQW343S22S28	81348	1.0	I
XU1	360230	SOCKET,DIP,08 PIN	ICO-083-S8-T	06776	1.0	E
1	4000-764-1	PWB,MOTHER,3 HEATSINK	4000-764	16067	1.0	E
2	210771	STANDOFF,SWGE,1/4-20X1/2"	G-13326-H-B-.1"	51506	3.0	E
3	FS3044	STANDOFF,SWGE,6-32 X 1/4	150B-1/4	88245	9.0	E
4	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	96906	2.0	E
5	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	2.0	E
6	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	2.0	E
7	4000-413-1	CABLE ASSY,RIBBON,34 PIN	4000-413	16067	1.0	E
8	4000-417-1	CABLE ASSY,RIBBON,50 PIN	4000-417	16067	1.0	E
9	4000-418-1	CABLE ASSY,OSCILLATOR	4000-418 REV F	16067	1.0	E
10	4000-050-1	HARNESS ASSY	4000-050 REV K	16067	1.0	E
11	FS3017	CONN,PC HDR,8 PIN	10-89-1081	27264	1.0	E
12	4000-275-1	BRACKET,MTG,PC ASSY	4000-275	16067	1.0	E
13	4000-276-1	BRACKET,MTG,PC ASSY	4000-276	16067	1.0	E
14	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	2.0	E
15	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	2.0	E
16	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	2.0	E
17	210834	STANDOFF,SWGE,6-32X3/16	30460-632-A	55566	1.0	E
18	4000-280-1	INSULATOR	4000-280-1	16067	1.0	E

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
C1	611124	CAP,AL,9500UF,75V	3196DC952U075HM	80031	1.0	EA
C2	611124	CAP,AL,9500UF,75V	3196DC952U075HM	80031	1.0	EA
C3	611124	CAP,AL,9500UF,75V	3196DC952U075HM	80031	1.0	EA
C4	611124	CAP,AL,9500UF,75V	3196DC952U075HM	80031	1.0	EA
C5	611124	CAP,AL,9500UF,75V	3196DC952U075HM	80031	1.0	EA
C6	611124	CAP,AL,9500UF,75V	3196DC952U075HM	80031	1.0	EA
C11	611123	CAP,MYLAR,.22UF,270V	912A1E224K	14752	1.0	EA
F1	270109	FUSE,1/8A,250V,SLO-BLO	313.125	75915	1.0	EA
J1	410352	CONN,PC HDR,16 PIN	26-48-1165	27264	1.0	EA
R1	540028	RES,CARB,2W,390 OHM	RC42GF391J	81349	1.0	EA
T1	4000-010-1	TRANSFORMER,BIAS	4000-010-1	16067	1.0	EA
1	4000-750-1	PWB,FILTER	4000-750-1	81349	1.0	EA
2	250314	FUSE CLIP,1/4",EAR	798	79963	2.0	EA
3	210771	STANDOFF,SWGE,1/4-20X1/2*	G-13326-H-B-.1*	51506	4.0	EA
4	FS2025	LUG,S/O,F,CRMP,22/18-.110	S070909SF	14726	2.0	EA
5	FS5041	WIRE,BU,MIL-W-16878/4	AWG 18,WHT	81349	4.0	IN
6	CIC739	BRDG,RECT,TPFW,100A,200V	CIC739	16067	1.0	EA
7	FS1071	WASHER,INTER,S/S,#10	MS35333-73	96906	2.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310281	BRDG,RECT,FW,4A,200V	MDA970G3	04713	1.0	EA
CR2	310254	BRDG,RECT,FW,1A,200V,DIP	VM28	27683	1.0	EA
CR3	310281	BRDG,RECT,FW,4A,200V	MDA970G3	04713	1.0	EA
CR4	310254	BRDG,RECT,FW,1A,200V,DIP	VM28	27683	1.0	EA
CR5	310254	BRDG,RECT,FW,1A,200V,DIP	VM28	27683	1.0	EA
CR6	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR7	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR8	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR9	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR10	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR11	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR12	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR13	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR14	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR15	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR16	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR17	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR18	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR19	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR20	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR21	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR22	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR23	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR24	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR25	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR26	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR27	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR28	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR29	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR30	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR31	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR32	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR33	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR34	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR35	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR36	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR37	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR38	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR39	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR40	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR41	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR43	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR44	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR45	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR47	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
CR48	310227	DIODE,SWNG,75V,.5W,DO35	1N4148	81349	1.0	EA
C1	611119	CAP,AL,15000UF,16V	80D153P016MB2	56289	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
C2	611121	CAP,AL,1000UF,35V	503D108M035QE	56289	1.0	EA
C3	611121	CAP,AL,1000UF,35V	503D108M035QE	56289	1.0	EA
C4	611120	CAP,AL,1800UF,80V	80D182P080KB2	56289	1.0	EA
C5	611120	CAP,AL,1800UF,80V	80D182P080KB2	56289	1.0	EA
C6	611121	CAP,AL,1000UF,35V	503D108M035QE	56289	1.0	EA
C7	611119	CAP,AL,15000UF,16V	80D153P016MB2	56289	1.0	EA
C8	611120	CAP,AL,1800UF,80V	80D182P080KB2	56289	1.0	EA
C9	611120	CAP,AL,1800UF,80V	80D182P080KB2	56289	1.0	EA
C10	610796	CAP,TANT,1UF,35V	T362A105M035AS	05397	1.0	EA
C11	610796	CAP,TANT,1UF,35V	T362A105M035AS	05397	1.0	EA
C12	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C13	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C14	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
C15	610750	CAP,TANT,4.7UF,10V	T362A475M010AS	05397	1.0	EA
C16	610760	CAP,TANT,1UF,50V	T36A105M050AS	05397	1.0	EA
C17	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
C18	611082	CAP,MYLAR,.1UF,100V	* 712A1BC104PK*	80031	1.0	EA
C19	610015	CAP,MICA,50PF,500V	DM15-500J	72136	1.0	EA
C20	611122	CAP,MYLAR,6.8UF,50V	11AA685K	000BH	1.0	EA
C21	611082	CAP,MYLAR,.1UF,100V	* 712A1BC104PK*	80031	1.0	EA
C22	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C23	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C24	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C25	610852	CAP,TANT,47UF,35V	T362D476M035AS	05397	1.0	EA
C26	611082	CAP,MYLAR,.1UF,100V	* 712A1BC104PK*	80031	1.0	EA
C27	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C28	611091	CAP,CER,22PF,25V	CN15C220J	71590	1.0	EA
C29	611088	CAP,CER,10PF,25V	CN15C100K	71590	1.0	EA
C30	611088	CAP,CER,10PF,25V	CN15C100K	71590	1.0	EA
C31	610750	CAP,TANT,4.7UF,10V	T362A475M010AS	05397	1.0	EA
C32	611091	CAP,CER,22PF,25V	CN15C220J	71590	1.0	EA
C33	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
C34	610750	CAP,TANT,4.7UF,10V	T362A475M010AS	05397	1.0	EA
C35	610030	CAP,MICA,150PF,500V	CM05F151J03	81349	1.0	EA
C36	610027	CAP,MICA,100PF,500V	CM05F101J03	81349	1.0	EA
C37	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C38	610929	CAP,MYLAR,.01UF,400V	712A1BB103PK40*	80031	1.0	EA
C39	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C40	610492	CAP,CER,2200PF,1000V	DD222	71590	1.0	EA
C41	610767	CAP,TANT,.1UF,35V	T362A104M035AS	05397	1.0	EA
C42	610291	CAP,MICA,470PF,500V	CM06F471J03	81349	1.0	EA
C43	610738	CAP,TANT,10UF,25V	T362A106M025AS	05397	1.0	EA
C44	611181	CAP,CER,1000PF,100V	5018EM100RD102K	51959	1.0	EA
C45	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C46	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C47	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
C48	610738	CAP,TANT,10UF,25V	T362A106M025AS	05397	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
C49	611143	CAP,CER,.0033UF,50V,NPO	CN20C332J	71590	1.0	EA
C50	610808	CAP,TANT,.22UF,50V	T362A224M050AS	05397	1.0	EA
C51	610967	CAP,TANT,22UF,15V	T362A226M015AS	05397	1.0	EA
C53	610808	CAP,TANT,.22UF,50V	T362A224M050AS	05397	1.0	EA
C54	610808	CAP,TANT,.22UF,50V	T362A224M050AS	05397	1.0	EA
C55	610620	CAP,MICA,250PF,500V	CM05F251J03	81349	1.0	EA
C56	610721	CAP,MYLAR,1UF,100V	112A1B105M	14752	1.0	EA
C57	FS7002	CAP,TBD	TBD	81349	1.0	EA
C58	611148	CAP,MYLAR,.1UF,100V	712A1BB104PK10*	80031	1.0	EA
C59	611148	CAP,MYLAR,.1UF,100V	712A1BB104PK10*	80031	1.0	EA
C60	610291	CAP,MICA,470PF,500V	CM06F471J03	81349	1.0	EA
C61	610291	CAP,MICA,470PF,500V	CM06F471J03	81349	1.0	EA
C62	611148	CAP,MYLAR,.1UF,100V	712A1BB104PK10*	80031	1.0	EA
C63	610750	CAP,TANT,4.7UF,10V	T362A475M010AS	05397	1.0	EA
C65	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C66	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C67	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C68	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C69	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C70	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C71	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C72	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C73	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C74	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C75	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C76	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C77	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C78	611103	CAP,CER,.1UF,50V,Z5U	CZ20C104M	71590	1.0	EA
C79	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
DS1	230080	LAMP,LED,GREEN	5082-4950	01295	1.0	EA
P1	410393	CONN,PC ST PLUG 100 PIN	PS50-4102-5	57856	1.0	EA
Q1	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q2	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q3	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q4	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q5	330289	TRANSISTOR,SS,NPN,TO92	PE8050	07263	1.0	EA
Q6	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q7	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q8	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q9	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q10	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q11	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q12	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q13	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q14	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q15	330324	TRANSISTOR,SS,NPN,TO92	MPSA42	04713	1.0	EA
Q16	330325	TRANSISTOR,SS,PNP,TO92	MPSA92	04713	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
Q17	330325	TRANSISTOR,SS,PNP,TO92	MPSA92	04713	1.0	EA
Q18	330324	TRANSISTOR,SS,NPN,TO92	MPSA42	04713	1.0	EA
Q19	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q20	330324	TRANSISTOR,SS,NPN,TO92	MPSA42	04713	1.0	EA
Q21	330325	TRANSISTOR,SS,PNP,TO92	MPSA92	04713	1.0	EA
Q22	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
Q23	330380	TRANSISTOR,SS,NPN,TO92	MPSA44	04713	1.0	EA
Q25	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q26	330315	TRANSISTOR,PWR,PNP,TO3	MJ15023	04713	1.0	EA
Q27	330285	TRANSISTOR,SS,PNP,TO92	PN2907A	07263	1.0	EA
Q28	330284	TRANSISTOR,SS,NPN,TO92	PN2222A	07263	1.0	EA
R1	550260	RES,PWR,3W,4.7K,5%	RSF2B-4.7K	56637	1.0	EA
R2	550260	RES,PWR,3W,4.7K,5%	RSF2B-4.7K	56637	1.0	EA
R3	560751	RES,FILM,1/8W,93.1K,1%	RN55D9312F	81349	1.0	EA
R4	570260	POT,1T,PC,5K	63P502	02111	1.0	EA
R5	560074	RES,FILM,1/4W,8.25K,1%	RN60D8251F	81349	1.0	EA
R6	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R7	560940	RES,FILM,1/8W,16.5K,1%	RN55D1652F	81349	1.0	EA
R8	560770	RES,FILM,1/8W,1K,1%	RN55D1001F	81349	1.0	EA
R9	560888	RES,FILM,1/8W,1.43K,1%	RN55D1431F	81349	1.0	EA
R10	510078	RES,CARB,1/4W,12K OHM	RC07GF123J	81349	1.0	EA
R11	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R12	510108	RES,CARB,1/4W,220K OHM	RC07GF224J	81349	1.0	EA
R13	510144	RES,CARB,1/4W,1.5M OHM	RC07GF155J	81349	1.0	EA
R14	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R15	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R16	510064	RES,CARB,1/4W,3.3K OHM	RC07GF332J	81349	1.0	EA
R17	510072	RES,CARB,1/4W,6.8K OHM	RC07GF682J	81349	1.0	EA
R18	560857	RES,FILM,1/8W,42.2K,1%	RN55C4222F	81349	1.0	EA
R19	560762	RES,FILM,1/8W,10K,1%	RN55D1002F	81349	1.0	EA
R20	510088	RES,CARB,1/4W,33K OHM	RC07GF333J	81349	1.0	EA
R21	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R22	560834	RES,FILM,1/8W,2.74K,1%	RN55C2741F	81349	1.0	EA
R23	560756	RES,FILM,1/8W,12.1K,1%	RN55C1212F	81349	1.0	EA
R24	560886	RES,FILM,1/8W,17.8K,1%	RN55D1782F	81349	1.0	EA
R25	510120	RES,CARB,1/4W,750K OHM	RC07GF754J	81349	1.0	EA
R26	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R27	510112	RES,CARB,1/4W,330K OHM	RC07GF334J	81349	1.0	EA
R28	510041	RES,CARB,1/4W,330 OHM	RC07GF331J	81349	1.0	EA
R29	560800	RES,FILM,1/8W,75K,1%	RN55D7502F	81349	1.0	EA
R31	510115	RES,CARB,1/4W,470K OHM	RC07GF474J	81349	1.0	EA
R32	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R33	510088	RES,CARB,1/4W,33K OHM	RC07GF333J	81349	1.0	EA
R34	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R35	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R36	560859	RES,FILM,1/8W,150K,1%	RN55C1503F	81349	1.0	EA
R37	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
R38	560573	RES,FILM,1/8W,100K,1%	RN55D1003F	81349	1.0	EA
R39	560840	RES,FILM,1/8W,110K,1%	RN55C1103F	81349	1.0	EA
R40	560823	RES,FILM,1/8W,11.0K,1%	RN55D1102F	81349	1.0	EA
R41	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R42	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R43	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R44	560945	RES,FILM,1/8W,5.62K,1%	RN55D5621F	81349	1.0	EA
R45	560768	RES,FILM,1/8W,6.19K,1%	RN55D6191F	81349	1.0	EA
R46	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R47	510080	RES,CARB,1/4W,15K OHM	RC07GF153J	81349	1.0	EA
R48	560783	RES,FILM,1/8W,30.9K,1%	RN55D3092F	81349	1.0	EA
R49	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	EA
R50	560573	RES,FILM,1/8W,100K,1%	RN55D1003F	81349	1.0	EA
R51	560945	RES,FILM,1/8W,5.62K,1%	RN55D5621F	81349	1.0	EA
R52	560768	RES,FILM,1/8W,6.19K,1%	RN55D6191F	81349	1.0	EA
R53	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R54	560783	RES,FILM,1/8W,30.9K,1%	RN55D3092F	81349	1.0	EA
R55	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	EA
R56	560837	RES,FILM,1/8W,47.5K,1%	RN55C4752F	81349	1.0	EA
R57	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R58	560573	RES,FILM,1/8W,100K,1%	RN55D1003F	81349	1.0	EA
R59	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R60	560871	RES,FILM,1/8W,3.32K 1%	RN55D3321F	81349	1.0	EA
R61	560887	RES,FILM,1/8W,464 OHM,1%	RN55C4640F	81349	1.0	EA
R62	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R63	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R64	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	EA
R65	560573	RES,FILM,1/8W,100K,1%	RN55D1003F	81349	1.0	EA
R66	560842	RES,FILM,1/8W,316K,1%	RN55C3163F	81349	1.0	EA
R67	560760	RES,FILM,1/8W,12.4K,1%	RN55C1242F	81349	1.0	EA
R68	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	EA
R69	510144	RES,CARB,1/4W,1.5M OHM	RC07GF155J	81349	1.0	EA
R70	560796	RES,FILM,1/8W,49.9K,1%	RN55D4992F	81349	1.0	EA
R71	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R72	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R73	560918	RES,FILM,1/8W,2.10K,1%	RN55D2101F	81349	1.0	EA
R74	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R75	570300	POT,1T,PC,5K	62-3-2-502	02111	1.0	EA
R76	560745	RES,FILM,1/8W,442K,1%	RN55D4423F	81349	1.0	EA
R77	560745	RES,FILM,1/8W,442K,1%	RN55D4423F	81349	1.0	EA
R78	510057	RES,CARB,1/4W,1.5K OHM	RC07GF152J	81349	1.0	EA
R79	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R80	560875	RES,FILM,1/8W,221 OHM,1%	RN55D221OF	81349	1.0	EA
R81	560812	RES,FILM,1/8W,90.9K,1%	RN55D9092F	81349	1.0	EA
R82	560793	RES,FILM,1/8W,562K,1%	RN55D5623F	81349	1.0	EA
R83	510033	RES,CARB,1/4W,150 OHM	RC07GF151J	81349	1.0	EA
R84	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA

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R85	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R86	510123	RES,CARB,1/4W,1M OHM	RC07GF105J	81349	1.0	EA
R87	560768	RES,FILM,1/8W,6.19K,1%	RN55D6191F	81349	1.0	EA
R88	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R89	560573	RES,FILM,1/8W,100K,1%	RN55D1003F	81349	1.0	EA
R90	560791	RES,FILM,1/8W,30.1K,1%	RN55D3012F	81349	1.0	EA
R91	560762	RES,FILM,1/8W,10K,1%	RN55D1002F	81349	1.0	EA
R92	560796	RES,FILM,1/8W,49.9K,1%	RN55D4992F	81349	1.0	EA
R93	560879	RES,FILM,1/8W,2.21K,1%	RN55D2211F	81349	1.0	EA
R94	560791	RES,FILM,1/8W,30.1K,1%	RN55D3012F	81349	1.0	EA
R95	570301	POT,1T,PC,1K	62-3-2-102	02111	1.0	EA
R96	560901	RES,FILM,1/8W,787K,1%	RN55D7873F	81349	1.0	EA
R97	560770	RES,FILM,1/8W,1K,1%	RN55D1001F	81349	1.0	EA
R98	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R99	560824	RES,FILM,1/8W,681 OHM,1%	RN55D6810F	81349	1.0	EA
R100	560573	RES,FILM,1/8W,100K,1%	RN55D1003F	81349	1.0	EA
R101	560796	RES,FILM,1/8W,49.9K,1%	RN55D4992F	81349	1.0	EA
R102	560768	RES,FILM,1/8W,6.19K,1%	RN55D6191F	81349	1.0	EA
R103	560767	RES,FILM,1/8W,24.3K,1%	RN55D2432F	81349	1.0	EA
R104	560577	RES,FILM,1/8W,20K,1%	RN55D2002F	81349	1.0	EA
R105	560874	RES,FILM,1/8W,165K,1%	RN55D1653F	81349	1.0	EA
R106	560767	RES,FILM,1/8W,24.3K,1%	RN55D2432F	81349	1.0	EA
R107	560742	RES,FILM,1/8W,2K,1%	RN55C2001F	81349	1.0	EA
R108	570301	POT,1T,PC,1K	62-3-2-102	02111	1.0	EA
R109	560762	RES,FILM,1/8W,10K,1%	RN55D1002F	81349	1.0	EA
R110	560752	RES,FILM,1/8W,4.75K,1%	RN55C4751F	81349	1.0	EA
R111	560873	RES,FILM,1/8W,237K,1%	RN55D2373F	81349	1.0	EA
R112	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	EA
R113	510068	RES,CARB,1/4W,4.7K OHM	RC07GF472J	81349	1.0	EA
R114	560767	RES,FILM,1/8W,24.3K,1%	RN55D2432F	81349	1.0	EA
R115	560840	RES,FILM,1/8W,110K,1%	RN55C1103F	81349	1.0	EA
R116	560823	RES,FILM,1/8W,11.0K,1%	RN55D1102F	81349	1.0	EA
R117	560945	RES,FILM,1/8W,5.62K,1%	RN55D5621F	81349	1.0	EA
R118	560795	RES,FILM,1/8W,309K,1%	RN55D3093F	81349	1.0	EA
R119	560926	RES,FILM,1/8W,7.32K,1%	RN55D7321F	81349	1.0	EA
R120	560762	RES,FILM,1/8W,10K,1%	RN55D1002F	81349	1.0	EA
R121	560841	RES,FILM,1/8W,200K,1%	RN55C2003F	81349	1.0	EA
R122	560752	RES,FILM,1/8W,4.75K,1%	RN55C4751F	81349	1.0	EA
R123	570292	POT,MT,PC,50K,1/2W,10%	64Y503T000	02111	1.0	EA
R124	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R125	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R126	510108	RES,CARB,1/4W,220K OHM	RC07GF224J	81349	1.0	EA
R127	510108	RES,CARB,1/4W,220K OHM	RC07GF224J	81349	1.0	EA
R128	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R129	560842	RES,FILM,1/8W,316K,1%	RN55C3163F	81349	1.0	EA
R130	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R131	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA

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R132	560942	RES,FILM,1/8W,8.66K,1%	RN55D8661F	81349	1.0	EA
R133	560759	RES,FILM,1/8W,2.37K,1%	RN55C2371F	81349	1.0	EA
R134	560079	RES,FILM,1/4W,10K,1%	RN60D1002F	81349	1.0	EA
R135	560079	RES,FILM,1/4W,10K,1%	RN60D1002F	81349	1.0	EA
R136	560759	RES,FILM,1/8W,2.37K,1%	RN55C2371F	81349	1.0	EA
R137	510123	RES,CARB,1/4W,1M OHM	RC07GF105J	81349	1.0	EA
R138	560818	RES,FILM,1/8W,499 OHM,1%	RN55D4990F	81349	1.0	EA
R139	560818	RES,FILM,1/8W,499 OHM,1%	RN55D4990F	81349	1.0	EA
R140	560893	RES,FILM,1/8W,7.5K,1%	RN55D7501F	81349	1.0	EA
R141	560796	RES,FILM,1/8W,49.9K,1%	RN55D4992F	81349	1.0	EA
R142	560826	RES,FILM,1/8W,36.5K,1%	RN55D3652F	81349	1.0	EA
R143	560762	RES,FILM,1/8W,10K,1%	RN55D1002F	81349	1.0	EA
R144	560716	RES,FILM,1/8W,4.64K,1%	RN55D4641F	81349	1.0	EA
R145	560770	RES,FILM,1/8W,1K,1%	RN55D1001F	81349	1.0	EA
R146	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R147	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R148	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R149	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R150	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R151	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R152	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R153	510041	RES,CARB,1/4W,330 OHM	RC07GF331J	81349	1.0	EA
R154	530080	RES,CARB,1W,33 OHM	RC32GF330J	81349	1.0	EA
R155	550010	RES,PWR,3W,.5 OHM,3%	RS-2B-.5 OHM	91637	1.0	EA
R156	530080	RES,CARB,1W,33 OHM	RC32GF330J	81349	1.0	EA
R157	570273	POT,1T,PC,100K	62-3-104	02111	1.0	EA
R158	560950	RES,FILM,1/8W,11.3K,1%	RN55D1132F	81349	1.0	EA
R159	560838	RES,FILM,1/8W,1.5M,1%	RN55C1504F	81349	1.0	EA
R160	560770	RES,FILM,1/8W,1K,1%	RN55D1001F	81349	1.0	EA
R161	560529	RES,FILM,1/8W,4.99K,1%	RN55C4991F	81349	1.0	EA
R162	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R163	570300	POT,1T,PC,5K	62-3-2-502	02111	1.0	EA
R164	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R165	510045	RES,CARB,1/4W,470 OHM	RC07GF471J	81349	1.0	EA
R166	510100	RES,CARB,1/4W,100K OHM	RC07GF104J	81349	1.0	EA
R167	510108	RES,CARB,1/4W,220K OHM	RC07GF224J	81349	1.0	EA
R168	510084	RES,CARB,1/4W,22K OHM	RC07GF223J	81349	1.0	EA
TP1	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP2	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP3	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP4	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP5	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP6	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP9	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
P10	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
P11	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
P12	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA

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TP13	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP14	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP15	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP16	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP17	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP18	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP19	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP20	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP21	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP22	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP23	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP24	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP25	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP26	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP27	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP28	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP29	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP30	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP31	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
TP32	FS2046	TERMINAL,QCK CLP,PC,MALE	835	79963	1.0	EA
U1	360218	IC,COMPARATOR,QUAD	LM339N	27014	1.0	EA
U2	360029	IC,OP-AMP,GP	LM201AN	27014	1.0	EA
U3	360463	IC,TIMER,DUAL	ICM7556IPD	32293	1.0	EA
U4	360595	IC,OPTO,CPLER,TRANS	MOC8204	04713	1.0	EA
U5	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U6	360219	IC,COMPARATOR,DUAL	LM393N	27014	1.0	EA
U7	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U8	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U9	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U10	360163	IC,MOS,EXCL OR,2-IN,QUAD	CD4070BE	18722	1.0	EA
U11	360309	IC,OPTO,COUPLER,FET	H11F2	09214	1.0	EA
U12	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U13	360309	IC,OPTO,COUPLER,FET	H11F2	09214	1.0	EA
U14	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U15	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U16	360307	IC,OP-AMP,FET,PREC	LF411	27014	1.0	EA
U17	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
U18	360530	IC,OP-AMP,FET,DUAL	UPC812	33297	1.0	EA
VR1	360032	IC,VOLTAGE REG,+5,1A	LM340-5T	27014	1.0	EA
VR2	360251	IC,VOLTAGE REG,+15,1A	MC7815CT	04713	1.0	EA
VR3	360252	IC,VOLTAGE REG,-15,1A	MC7915CT	04713	1.0	EA
VR4	360251	IC,VOLTAGE REG,+15,1A	MC7815CT	04713	1.0	EA
VR5	310269	IC,VOLTAGE REG,+VAR	TL 431 CLP	01295	1.0	EA
VR6	310016	DIODE,ZNR,6.2V,.4W,5%	1N753A	04713	1.0	EA
VR7	310269	IC,VOLTAGE REG,+VAR	TL 431 CLP	01295	1.0	EA
VR8	310129	DIODE,ZNR,3.3V,.5W,5%	1N5226B	04713	1.0	EA
VR9	310270	DIODE,ZNR,14V,.5W,5%	1N5244B	04713	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
VR10	310269	IC,VOLTAGE REG,+VAR	TL 431 CLP	01295	1.0	EA
VR11	310298	DIODE,ZNR,18V,.5W,5%	1N5248B	04713	1.0	EA
VR12	310298	DIODE,ZNR,18V,.5W,5%	1N5248B	04713	1.0	EA
VR13	360278	IC,REF,+10	CIC738	16067	1.0	EA
VR14	310269	IC,VOLTAGE REG,+VAR	TL 431 CLP	01295	1.0	EA
VR15	310269	IC,VOLTAGE REG,+VAR	TL 431 CLP	01295	1.0	EA
VR16	310016	DIODE,ZNR,6.2V,.4W,5%	1N753A	04713	1.0	EA
VR17	310206	DIODE,ZNR,12V.5W,5%	1N5242B	04713	1.0	EA
VR18	310206	DIODE,ZNR,12V.5W,5%	1N5242B	04713	1.0	EA
VR19	310169	DIODE,ZNR,10V,.5W,5%	1N5240B	04713	1.0	EA
VR20	310251	DIODE,ZNR,8.2V,.5W,5%	1N5237B	04713	1.0	EA
VR21	310251	DIODE,ZNR,8.2V,.5W,5%	1N5237B	04713	1.0	EA
VR22	310251	DIODE,ZNR,8.2V,.5W,5%	1N5237B	04713	1.0	EA
W1	FS5119	WIRE,BUS,AWG 22,QQ-W-343E	QQW343S22S2B	81348	1.0	IN
W2	250396	JUMPER BLOCK	90059-0009	27264	1.0	EA
W4	250396	JUMPER BLOCK	90059-0009	27264	1.0	EA
Z1	360459	RES,ARRAY,SIP,,4.7K	110B472	01121	1.0	EA
Z2	360450	RES,ARRAY,SIP,10K	110B103	01121	1.0	EA
Z3	360460	RES,ARRAY,SIP,22K	106B223	01121	1.0	EA
Z4	360460	RES,ARRAY,SIP,22K	106B223	01121	1.0	EA
Z5	360455	RES,ARRAY,TFLM,DIP,10K	699-3-10K-F	73138	1.0	EA
Z6	360449	RES,ARRAY,SIP,100K	106B104	01121	1.0	EA
1	4000-774-1	PWB,PRE-AMPLIFIER	4000-774-1	16067	1.0	EA
2	410492	CONN,PC HDR,4 PIN	10-89-1041	27264	2.0	EA
3	210913	HEATSINK	5759B-3	30161	2.0	EA
4	210737	HEATSINK,TO220	LAE66A2CB	98978	1.0	EA
5	210829	HEATSINK,TO220	288-2-AB	05820	2.0	EA
6	FS1031	SCREW,PNH,S/S,6-32X7/16	MS51957-29	81349	4.0	EA
7	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	2.0	EA
8	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	96906	2.0	EA
9	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51957-13	96906	2.0	EA
10	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	6.0	EA
11	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	4.0	EA
12	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	6.0	EA
13	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	4.0	EA
14	FS4001	THERMAL COMPOUND	351	13103	.1	OZ

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
Q1	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q2	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q3	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q4	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q5	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q6	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q7	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
Q8	330317	TRANSISTOR,PWR,NPN,TO3	MJ15022	04713	1.0	EA
S1	360462	IC,ANA,TEMP TRANSDUCER	AD592AN	24355	1.0	EA
W1	FS5122	WIRE,BUS,AWG 16,QQ-W-34	QQW343S16S2B	81348	1.0	IN
1	4000-709-1	PC ASSY,POWER AMP	4000-709 REV A	16067	1.0	EA
2	4000-761-1	PWB,JUMPER BOARD	4000-761-1	16067	1.0	EA
3	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	6.0	EA
4	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	23.0	EA
5	4000-222-1	HEATSINK,AMPLIFIER	4000-222-1	16067	1.0	EA
6	FS1094	SCREW,CTG,PNH,6-20X9/16	#6X9/16 TYPE B	81349	16.0	EA
7	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	1.0	EA
8	4000-292-1	BRACKET,HEATSINK	4000-292-1	16067	1.0	EA
10	210781	INSULATOR,SIL-PAD,TO3	1009-05	55285	1.0	EA
11	FS4001	THERMAL COMPOUND	351	13103	1.0	OZ

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	U
CR1	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR2	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR3	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR4	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR5	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR6	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR7	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR8	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	E
CR9	310280	DIODE,RECT,24A,200V	MR2402	04713	1.0	E
J1	410392	CONN,PC 40 PIN,90D	PR20-6142-5	00093	1.0	E
R1	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R2	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R3	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R4	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R5	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R6	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R7	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R8	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R9	560684	RES,FILM,1/8W,100 OHM,1%	RN55D1000F	81349	1.0	E
R10	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R11	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R12	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R13	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R14	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R15	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R16	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
R17	4000-020-1	RES,PWR,5W,.2 OHM,5%	4000-020-1	33901	1.0	E
1	4000-759-1	PWB,POWER AMPLIFIER	4000-759-1	16067	1.0	E
2	FS3044	STANDOFF,SNGE,6-32 X 1/4	150B-1/4	88245	8.0	E
3	250411	SOCKET,XSTR,TO-3	1001-11	55982	8.0	E
4	250418	SOCKET,PC COMPONENT LEAD	1-380758-0	00779	3.0	E

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	4000-401-1	HEATSINK ASSY,PWR AMP	4000-401 REV D	16067	1.0	EA

PARENT ITEM NO.
4000-403-2

FRONT PANEL ASSY
ENGR DRAW NO. 4000-403 REV F

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
DS1	250412	LAMP,NEON,AMBER,120V	1050QN3	91802	1.0	EA
2	4000-235-2	PANEL,FRONT W/4000-100	4000-235-2	16067	1.0	EA
3	4000-237-1	BRACKET,MOUNTING,PWB	4000-237-1	16067	1.0	EA
4	240225	HANDLE,FLT,AL,4-9/16"	11519-A-0832-1B	06540	2.0	EA
10	FS1046	SCREW,FLH,S/S,8-32X5/8	MS24693-C51	96906	4.0	EA
11	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	1.0	EA
13	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	1.0	EA

PARENT ITEM NO.
4000-407-1

REAR PANEL ASSY
ENGR DRAW NO. 4000-407 REV E

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	U
B1	241175	FAN,4",48VDC	4148X	77062	1.0	E
R6	FS7001	RES,CARB,2W,T&D	RC42GF...	81349	1.0	E
TB1	240321	TERMINAL BLK, 3TERM,85A	9-85-3	75382	1.0	E
TB2	240321	TERMINAL BLK, 3TERM,85A	9-85-3	75382	1.0	E
TB5	250132	TERMINAL STRP, 3TERM,LMT	857	83330	1.0	E
1	4000-246-1	PANEL,REAR W/4000-246	4000-246-1	16067	1.0	E
2	241064	FAN GUARD	550481	32877	1.0	E
3	FS1118	SCREW,PNH,S/S,6-32X2-1/4	6-32X2-1/4	81349	4.0	E
4	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	7.0	E
5	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	6.0	E
8	FS5021	WIRE,BU,MIL-W-16878/4	AWG 22,WHT	81349	7.0	I
9	4000-284-1	WIRE,BU,MIL-W-16878/4	AWG 22,WHT	81349	7.0	I
11	FS1064	SHROUD,4" FAN	4000-284-1	16067	1.0	E
12	FS1158	NUT,HEX,S/S,6-32	MS35649-264	96906	1.0	E
14	FS1032	SCREW,PNH,S/S,6-32X1-1/4	MS51957-35	96906	4.0	E
16	4000-278-7	SCREW,PNH,S/S,6-32X1/2	MS51957-30	96906	2.0	E
17	FS1079	STANDOFF,M/F,4-40	4000-278-7	16067	2.0	E
18	FS1072	WASHER,FLAT,S/S,#4	MS15795-804	96906	2.0	E
19	FS1066	WASHER,SPLT,S/S,#4	MS35338-135	96906	2.0	E
20	4000-715-1	NUT,HEX,S/S,4-40	MS35649-244	96906	2.0	E
21	210173	PC ASSY,PHASE SELECTOR	4000-715 REV C	16067	1.0	E
22	210089	GROMMET,RUBBER,7/16"DIA	3241	08065	1.0	E
24	4848-205-1	GROMMET,RUBBER,7/8"DIA	2187	83330	1.0	E
25	210679	CABLE ASSY,GPIB(-PC)	4848-205-1	16067	1.0	E
		JACK SOCKET,GPIB	552633-4	00779	1.0	S

PARENT ITEM NO.
4000-408-1

HEATSINK SPACER ASSY
ENGR DRAW NO. 4000-408 REV 0

5/02/85

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	4000-258-1	SPACER,HEATSINK	4000-258-1	16067	1.0	EA
2	4000-259-1	COVER,TOP & BOTTOM	4000-259-1	16067	2.0	EA
3	FS4016	ADHESIVE/SEALANT,LOCTITE	38050	05972	1.0	EA
4	4000-225-2	INSULATOR,HEATSINK,.250	4000-225-2	16067	2.0	EA
5	4000-260-1	SPACER,INDEXING	4000-260-1	16067	1.0	EA

California INSTRUMENTS

INSTRUCTION MANUAL
MODEL 651XP-EF

Invertron®

SECTION I

GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration and maintenance of the California Instruments XP Series AC Power Sources Model 321XP, 651XP, 971XP and 1301XP.

1.2 SPECIFICATIONS

Table 1-1 contains the operating specifications for XP Series power sources. All specifications are tested in accordance with standard California Instruments test procedures and apply with a stable, low distortion input signal as generated by any XP-series oscillator/power controller. The following specifications apply for operation from 78% to 100% of full scale output voltage.

TABLE 1-1 SPECIFICATIONS
XP-SERIES POWER SOURCE

MODEL	321XP	651XP	971XP	1301XP
MAXIMUM OUTPUT POWER, VA				
@ TA=25 degrees C, 77.8% of Range 0.7 Power Factor	325	650	975	1,300
@ TA=25 degrees C, 100% of Range 0.7 Power Factor, 45 Hz to 5 KHz	419	836	1,252	1,671
(5KHz to 10 KHz)			(975)	(1,300)
@ TA=55 degrees C, 77.8% of Ramge 0.7 Power Factor	250	500	750	1,000
@ TA=55 degrees C, 100% of Range 0.7 Power Factor, 45 Hz to 5 KHz	321	642	964	1,285
(5KHz to 10 KHz)			(750)	(1,000)
MAXIMUM OUTPUT CURRENT, Arms				
@ TA=25 degrees C				
67.5 Volt Range	6.19	12.38	18.56	24.76
135 Volt Range	3.10	6.19	9.28	12.38
270 Volt Range	1.55	3.10	4.64	6.19

@ TA=55 degrees C

67.5 Volt Range	4.76	9.52	14.28	19.04
135 Volt Range	2.38	4.76	7.14	9.52
270 Volt Range	1.19	2.38	3.57	4.76

OUTPUT VOLTAGE RANGES:
0-135 volts rms
0-270 volts rms

OPTIONAL:
0-67.5 volts rms
0-135 volts rms

Voltage range selectable by front panel range key or via IEEE-488 bus when used with the XP-series programmable oscillators/AC power controllers.

LOAD REGULATION:
±1% over the range from 45 Hz to 5 KHz when tested at unity power factor.
±5% 5 KHz to 10 KHz, unity power factor.

TOTAL HARMONIC DISTORTION:
Less than 0.5% from 45 Hz to 5 KHz. Less than 1.0% from 5 KHz to 10 KHz.

LINE REGULATION:
±0.1% of full output for a ±10% line change.

AMPLITUDE STABILITY:
±0.25% for 24 hours at constant line, load and ambient temperature.

FULL POWER FREQUENCY RANGE:
45 Hz to 10 KHz (Optional 15 Hz at derated power, 33% voltage and 30% power).

FREQUENCY RESPONSE:
±0.5dB 45 Hz to 10 KHz.

PHASE MATCHING:
(Between identical power source models)
±1.5 degrees 45 to 2 KHz.
±.5 degree/KHz. Does not include phase inaccuracy of oscillator drive signals.

EFFICIENCY:

321XP	651XP	971XP	1301XP
43%	52%	55%	53%

at full power out at 135V at unity power factor

AC NOISE LEVEL:	70dB rms below full rms output with shorted input. 60dB below full peak-to-peak output with shorted input. 50dB below full peak-to-peak output at full rated power output.
OVERLOAD/SHORT CIRCUIT OVERPOWER PROTECTION:	A fault resulting from overloading, short circuit or overpower condition will cause an "OVERLOAD" indicator to illuminate on the front panel. The output voltage will then be clipped on the peaks. Clipping will be proportional to the amount of the overload.
OVERTEMPERATURE PROTECTION:	Thermal overload resulting from excessive heatsink temperature will cause an "OVERTEMP" indicator to illuminate on the front panel and the output voltage will drop to zero.
AMPLIFIER DRIVE: (normally obtained from plug-in oscillator through Power Monitor)	5 volts rms (typical) produces full scale output.
PROGRAMMABLE CURRENT LIMIT OPTION:	Current Limit programming is in peak amperes. The accuracy is ±5% of programmed value from 10% to 100% of rated output.
AC MAINS INPUT:	Models 321XP and 651XP normally wired for 103 to 135 VAC. Models 971XP and 1301XP normally wired for 180 to 253 VAC. The AC INPUT may be rewired for any of the three input ranges, 103 to 135 VAC, 180 to 253 VAC or 207 to 270 VAC. NOTE: When rewired the AC input check Table 2-3 for the correct circuit breaker.
AC MAINS FREQUENCY:	48 Hz to 65 Hz.
OPERATING TEMPERATURE RANGE:	0 to 55 degrees C.
STORAGE TEMPERATURE RANGE:	-25 degrees to 85 degrees C.

ACOUSTIC NOISE:	Less than 60 dB maximum when mounted in equipment rack measured three feet from front center, "A" weighted scale.
FRONT PANEL METER: (For Power Monitor specifications, refer to applicable Power Monitor Instruction Manual)	Monitors output voltage or load current. Resolution is 1 volt or 0.1 ampere. With "kiloWatts" option resolution is 10 watts.
FRONT PANEL INDICATORS:	"POWER ON" "RANGE" "OVERLOAD" "OVERTEMP"
FRONT PANEL CONTROLS:	
Amplifier:	Main Circuit Breaker
Power Monitor:	Range; IMB, IMC Volts; IMB, IMC Amp: IMB, IMC KiloWatt; IMC
INPUT/OUTPUT CONNECTORS:	AC MAINS INPUT provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Output provided on rear mounted terminal block, Kulka 9-85-3. Servo Sense inputs for individual phases provided on Amp cap 1-480701-0 w/Amp Socket Contact 350689-1. The mating connector is Amp plug 1-480700-0 w/Amp contact pin 350547-1. Interfacing in a multi-phase system is provided with the California Instrument cable assembly 4000-427. The power source connector is Amp 552118-1. The mating connector is Amphenol 57-20500-15.

INPUT/OUTPUT CONNECTORS: (continued)	Oscillator/Control signals for programmable oscillators are provided on rear mounted IEEE-488 (GPIB) connector 3M 3549-1000.
DIMENSIONS: (in inches)	1301XP - 19W - 22D - 7.00H 971XP - 19W - 22D - 7.00H 651XP - 19W - 22D - 5.25H 321XP - 19W - 22D - 5.25H
NET WEIGHT:	1301XP 103 Pounds 971XP 92 Pounds 651XP 78 Pounds 321XP 59 Pounds
SHIPPING WEIGHT:	1301XP 131 Pounds 971XP 128 Pounds 651XP 114 Pounds 321XP 93 Pounds
FRONT PANEL FINISH:	Gray, 26440 per federal standard 595 with black silk-screened lettering.

PARENT ITEM NO.
4000-411-7

TOP ASSY, 651XP-EF
ENGR DRAW NO. 4000-411 REV M

6/03/88

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
	4000-050-0	HARNESS ASSY,JUMPER	4000-050 REV K	16067	1.0	EA
	4000-050-2	HARNESS ASSY	4000-050 REV K	16067	1.0	EA
	4000-050-6	HARNESS ASSY	4000-050 REV K	16067	1.0	EA
	4000-961	MANUAL,651XP	MANUAL REV D	16067	1.0	EA
A1	4000-714-1	PC ASSY,MOTHER BOARD	4000-714 REV G	16067	1.0	EA
A2	4000-700-2	PC ASSY,FILTER	4000-700 REV C	16067	1.0	EA
A3	4000-724-2	PC ASSY,PREAMP	4000-724 REV G	16067	1.0	EA
A4	4000-401-1	HEATSINK ASSY,PWR AMP	4000-401 REV D	16067	1.0	EA
A6	4000-401-3	HEATSINK ASSY,PWR AMP	4000-401 REV D	16067	1.0	EA
CB1	270128	CIRCUIT BREAKER,30A,250V0	UPGX-66-1-65-3*	81541	1.0	EA
C1	610881	CAP,MYLAR,.22UF,250V SB	713A1GG224PK251	80031	1.0	EA
C2	610929	CAP,MYLAR,.01UF,400V	712A1BB103PK40*	80031	1.0	EA
C3	610929	CAP,MYLAR,.01UF,400V	712A1BB103PK40*	80031	1.0	EA
C4	611137	CAP,PP,10UF,135VAC	935B1C106	14752	1.0	EA
K1	245182	RELAY,POWER,2C,30A,24VDC	21CPX-3 24VDC	94696	1.0	EA
L1	4000-011-1	INDUCTOR,.5MH,15A,E100	4000-011-1	16067	1.0	EA
R1	550189	RES,PWR,50W,.01 OHM,1%	RH-50-73-.01	91637	1.0	EA
R2	550008	RES,PWR,3W,5.1 OHM,1%	RS-2B-5.1 OHM	91637	1.0	EA
R3	FS7000	RES,CARB,1/4W,TBD	RC07GF...	81349	1.0	EA
R4	550278	RES,PWR,40W,150 OHM 5%	F40J150	44655	1.0	EA
R5	550278	RES,PWR,40W,150 OHM 5%	F40J150	44655	1.0	EA
R7	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R8	540012	RES,CARB,2W,10 OHM	RC42GF100J	81349	1.0	EA
R9	550279	RES,PWR,40W,250 OHM 5%	F40J250	44655	1.0	EA
R12	540071	RES,CARB,1W,4.7M OHM	RC32GF475J	81349	1.0	EA
R13	540071	RES,CARB,1W,4.7M OHM	RC32GF475J	81349	1.0	EA
R14	540071	RES,CARB,1W,4.7M OHM	RC32GF475J	81349	1.0	EA
TB4	250086	TERMINAL STRP, 6TERM,1MT	901	83330	1.0	EA
T1	4000-015-1	TRANSFORMER,INPUT	4000-015 REV D	16067	1.0	EA
T2	4000-014-1	TRANSFORMER,OUTPUT,10KHZ	4000-014-REV B	16067	1.0	EA
T3	CIC604-2	CUR TRANS BURDEN RES ASSY	CIC604-2 REV 0	16067	1.0	EA
1	FS1029	SCREW,FLH,S/S,6-32X3/8	MS24693-C26	96906	24.0	EA
2	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	15.0	EA
3	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	6.0	EA
4	FS1050	SCREW,FLH,S/S,8-32X7/16	MS24693-C49	81349	4.0	EA
5	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	7.0	EA
6	FS1065	NUT,HEX,S/S,8-32	MS35649-284	96906	11.0	EA
7	FS1086	NUT,HEX,S/S,4-40X3/16	4-40X3/16	81349	2.0	EA
8	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	11.0	EA
9	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	2.0	EA
10	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	27.0	EA
11	FS1074	WASHER,SPLT,S/S,#8	MS35338-137	96906	17.0	EA
12	FS1075	WASHER,SPLT,S/S,#10	MS35338-138	96906	11.0	EA
13	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	9.0	EA
14	FS1081	WASHER,FLAT,S/S,#8	MS15795-841	96906	9.0	EA
15	FS1147	WASHER,FLAT,1/4	MS15795-810	96906	8.0	EA
16	FS1167	NUT,HEX,S/S,1/4-20	MS35649-2254	96906	8.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
17	FS1173	WASHER,SPLT,1/4	MS35338-139	96906	15.0	EA
18	210892	STANDOFF,8-32 X 1 1/16	8162-N-0832	06540	1.0	EA
19	210787	STANDOFF,M/F,8-32X3-1/2"	AL6982-3.500-22	05791	1.0	EA
20	210816	SPACER, #8 X 7/8,ALUM	9234-A-171	06540	2.0	EA
22	330337	THYR,SCR,25A,800V	TT25N800KOC	24972	1.0	EA
27	4000-225-3	INSULATOR,HEATSINK,.250	4000-225-3	16067	2.0	EA
30	4000-226-1	COVER,SHROUD,4" FAN	4000-226	16067	1.0	EA
32	4000-403-2	FRONT PANEL ASSY	4000-403 REV F	16067	1.0	EA
34	4000-285-1	COVER,SIDE,SHROUD	4000-285-1	16067	1.0	EA
38	4000-407-1	REAR PANEL ASSY	4000-407 REV E	16067	1.0	EA
42	FS4001	THERMAL COMPOUND	351	13103	1.0	OZ
44	FS4016	ADHESIVE/SEALANT,LOCTITE	38050	05972	.0	OZ
47	4000-249-1	COVER,CHASSIS	4000-249-1	16067	1.0	EA
48	4000-408-1	HEATSINK SPACER ASSY	4000-408 REV 0	16067	1.0	EA
51	4000-263-1	BRACKET,MTG,TORUS	4000-263	16067	1.0	EA
52	FS1158	SCREW,PNH,S/S,6-32X1-1/4	MS51957-35	96906	1.0	EA
53	210309	BUMPER,RUBBER	2193	08065	1.0	EA
54	FS1043	SCREW,FLH,S/S,8-32X3/8	MS24693-C48	81349	2.0	EA
55	4000-241-1	CHASSIS	4000-241	16067	1.0	EA
56	FS1165	BOLT,HEX,S/S,1/4-20X1/2	MS35307-303	96906	7.0	EA
57	4000-236-1	BRACKET,REAR SUPPORT	4000-236	16067	1.0	EA
58	4000-426-1	HARNESS ASSY,JUMPER	4000-426	16067	2.0	EA
59	FS1099	WASHER,FLAT,FIBRE,#8X.44	2259-F171	06540	2.0	EA
60	FS1100	NUT,HEX,BRASS,8-32	4138B116	33855	4.0	EA
61	FS1103	WASHER,FLAT,S/S,#6X.310D	MS15795-805	81349	6.0	EA
65	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	12.0	EA
66	4000-252-1	COVER,TERM BD W/4000-252	4000-252	16067	1.0	EA
67	250419	TERM STRAP,COPPER	4805-16-3	86928	5.0	EA
68	FS1041	SCREW,PNH,S/S,8-32X5/16	MS59157-42	81349	13.0	EA
69	FS3001	GROMMET,STRIP,.085	CSG-09-BLACK	95987	12.0	IN
70	210841	BUMPER,RUBBER	5200-01-03-5053	02768	4.0	EA
71	FS1062	SCREW,PNH,S/S,10-32X3/4	MS51958-65	96906	4.0	EA
73	FS1135	SCREW,PNH,S/S,8-32X1-1/2	MS51957-51	81349	2.0	EA
74	250359	LUG,RING,SOLDER,#6	809	79963	4.0	EA
75	FS6003	TUBING,SHRINK,1/4	CP221-1/4-BLK	24011	4.0	IN
76	FS4005	NOMEX,.010 THK,NATURAL	NOMEX,.010 THK	81349	336.0	SI
77	FS4004	ADHESIVE,SPRAY	77	04963	.5	OZ
78	FS6003	TUBING,SHRINK,1/4	CP221-1/4-BLK	24011	22.0	IN
79	4995-146-1	DECAL,SCREW PENETRATION	4995-146-1	16067	1.0	EA
81	FS1013	SCREW,PNH,S/S,4-40X3/8	MS51957-15	96906	4.0	EA
82	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	4.0	EA
83	FS1079	WASHER,FLAT,S/S,#4	MS15795-804	96906	4.0	EA
84	FS1071	WASHER,INTER,S/S,#10	MS35333-73	96906	3.0	EA
85	FS1104	BOLT,HEX,BRS,10-32X1/2	10-32X1/2	81349	3.0	EA
87	4000-293-1	PLATE,MTG,RESISTOR	4000-293-1	16067	1.0	EA
88	4000-228-1	BRACKET,PLUG-IN,OSC	4000-228-1	16067	1.0	EA
89	210912	GUIDE,PWB,5.65	33-9016-12-01-*	91662	2.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
90	FS1024	SCREW,PNH,S/S,6-32X3/16	MS51957-25	96906	4.0	EA
91	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	4.0	EA
92	FS1168	BOLT,HEX,S/S,10-32X3/8	10-32X3/8	81349	4.0	EA

Appendix A

Number	Vendor Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Waddon,Surrey	GB
0000S(20564)	OPCDA (Relec Elect. Corp.)	Winsted	CT
0000W	Milton Bowe Co.	Southampton	PA
0000X(52745)	Timco	Los Angeles	CA
000AC	Itac	Santa Clara	CA
000AD(551112)	Pioneer (Westlake Cap. Inc.)	Westlake Village	CA
000AG	LaFrance	Philadelphia	PA
000AH(54363)	Jan Crystal	Ft. Myers	CA
000AL(53495)	Data Components, Inc.	Gardena	CA
000AM	Ecaus & Reimer	Santa Monica	CA
000AR	Rite Instrument Transformer	Redondo Beach	CA
000AT(62643)	Switches Incorporated	Mt. View	CA
000AU	United Chem[-]Con	Rosemont	IL
000AV(61837)	JMJ Technical Prod. Inc.	Kendall Park	NJ
000AW	Remi Processes, Inc.	San Jose	CA
000AZ(63678)	Apcromics	Chatsworth	CA
000AT	Silicon Power Cube Corp.	Manor	OR
000AZ(61271)	Fujitsu	Long Beach	CA
000BA(61964)	Omron Electronics, Inc.	Santa Clara	CA
000BB	Bellmart Metals, Inc.	Schaumburg	IL
000BC	Toshiba America, Inc.	Glendora	CA
000BD(55982)	Electronic Essentials	Tustin	CA
000BE(57856)	Eel-Am	Woodside	NY
000BF(55285)	Bergquist	Eldon	MO
000BG	Panasonic	Minneapolis	MN
000BH	Century Components	Secaucus	NY
000BI(54186)	Micro Power Systems	Canyon Country	CA
000BJ(66776)	Robinson Nugent	Santa Clara	CA
000BL(13150	Beau Products (Vernitron)	New Albany	IN
000BM(51725)	Corebinder (Gerrard AJ & Co.)	Laconia	NH
000BO	Mitsubishi Electronics Amer.	Des Plaines	IL
000BP	Silicon Power Cube	Sunnyvale	CA
000BR	Secoe	Long Beach	CA
000BS	Pamel Components Corp.	Bagnolet	France
00544	Metal-Cal Div., Avery Prod.	Santa Rosa	CA
00779	AMP Inc.	Inglewood	CA
00853	Kemcone Electronic Co.	Harrisburg	PA
00866	Coe Eng. Co., Inc.	Pickens	SC
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	City of Industry	CA
01121	Allen-Bradley Co.	John St. Hudson Falls	NY
01139	G.E. Co., Silicone Prod.	Milwaukee	WI
01295	Texas Instruments	Waterford	NY
01961	Pulse Engineering, Inc.	Dallas	TX
02111	Spectrol Electronics	San Diego	CA
02113	Calicraft, Inc.	City of Industry	CA
02335	Fairchild Controls Corp.	Cacy	IL
02375	American Insulating Mach. Co.	Richardville,LI	NY
02528	Texas Electronics Co.	Philadelphia	PA
02660	Amphenol Corporation	Dallas	TX
02768	Illinois Tool Works, Inc.	Broadview	IL
02799	Dun Code 171136	Des Plains	IL
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Claires Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec.	Hartford	CT
04099	Capco, Inc.	Grand Junction	CO
04713	Motorola Semiconductor Prod.	Phoenix	AZ
04729	Universal Components Corp.	Green Brook	NJ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics., Inc.	Pomona	CA
05397	Kennt, Union Carbide Corp.	Cleveland	OH
05791	Lyn-Tron, Inc.	Bertram	CA
05820	Wakefield Engineering, Inc.	Wakefield	MA
05972	Loctite Corp.	Newington	CT
06383	Panduit Corp.	Tinley Park	IL
06514	Stantron, Myco Metal Prod.	S. Hollywood	CA
06540	Amaton Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07008	Kelvin Electric Company	Van Nuys	CA
07261	Fairchild Camera & Instr.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Unitract Cabaco Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07707	USM Corp. (USM Fastener Div)	Shelton	CT
07716	IRC Incorporated	Burrington	IA
07910	Dun Code 415818		
08028	Loctite (Auto & Consumer Grp)	Rta View	CA
08057	Spang Ind. (Magnetics Div)	Sandy Lake	PA
08065	Accurate Rubber and Plastics	San Diego	CA
08261	Spectra Strip (Amphenol)	Garden Grove	
08289	Allen Deibert Co.	Pomona	CA
08353	Bristol Co. of Canada	Toronto, Ont	Canada
08730	Ostby & Barton (Vemaline Prod. Div.)	Warwick	RI
08779	Signal Transformer	Brooklyn	NY
09214	GE (Semiconductor Prod. Div)	Auburn	NY
09353	C & K Components	Newton	MA
09922	Burndy Corp.	Norwalk	CT
10389	Chicago Switch	Chicago	IL
11015	Cherry/Textron (Fastener Div)	Santa Ana	CA
12406	Elpac Electronics	Santa Ana	CA
12697	Clarostat Mfg.	Dover	NH
13103	Thermalloy Company	Dallas	TX
13150	Vernitron Corp (Beau Prod.)	Laconia	NH
13606	Sperry Corp. Elec. Systems	Great Neck	NY
13919	Burr-Brown	Tucson	AZ
14099	Exotech Corporation	Newbury Park	CA
14604	Elwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Bellingsworth Co.	Phoenixville	PA
14752	Electro Cube, Inc.	San Gabriel	CA
14988	Electronic Instrument and Specialty Corp.	Stoneham	MA
15238	ITT Semiconductors	Lawrence	MA
15454	Ametek Sm (Sudan Div)	Anaheim	CA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Amelex Teledyne, Inc.	Mt. View	CA
15912	Amelex	Los Angeles	CA
16467	California Instruments Co.	San Diego	CA
16758	Delco Radio Div., Gen. Mtrs.	Kokomo	IN
16956	Dominion	Framingham	MS
17854	Siliconix, Inc.	Santa Clara	CA
18076	Dupco	City of Industry	CA
18178	Vectec, Inc.	Maryland Heights	MO
18310	Concord Electronics Corp.	New York	NY
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments, Inc.	Malvern	PA
18677	Scanbe Mfg. Co. (Dale Corp.)	Monterey Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	Boelcon Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
21845	Solitron Devices (Semi-conductor Group)	Riviera Beach	FL
22598	Elastic Stop Nut Corp.	Van Nuys	CA
23050	Product Components Corp.	Bentinge-on-Hudson	NY
23936	Pamotor, Inc.	San Francisco	CA
24011	ECC	Burlington	MA
24355	Analog Devices, Inc.	Norwood	MA
24444	General Semiconductor Inc.	Tempe	AZ
24796	Pacelco, Inc.	Paramount	CA
24931	Specialty Connector Co., Inc.	Greenwood	IN
24972	AEG-Telefunken Corp.	Somerville	NJ
25403	Amperex Electronic Corp.	Slatersville	RI
25497	Meter Master	Los Angeles	CA
26485	Marathon Electric Mfg. Corp.	Bowling Green	OH
26806	American Ictiier, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Corp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27335	G & B Motor & Control Corp.	New York	NY
27556	INA Electronic Products	Santa Fe Springs	CA
27683	Vare, Inc.	St. Garland	TX
27735	F-Dyne Electronics	Bridgeport	CT
27832	Hughes Aircraft	Newport Beach	CA
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
28606	Echlin Ltd.	Rexdale Ont.	Canada
29372	Rexnord Inc. Tridair Ind.	Torrance	CA
29593	Bussco Eng. Inc.	El Segundo	CA
30039	International Components Crp.	Asbury Park	NJ
30161	Asvid Engineering, Inc.	Laconia	NH
30897	Dersom Company	Sylmar	CA
34983	Electra/Midland (Mepco/ Electra)	San Diego	CA
31827	Budwig Mfg. Co.	Ramona	CA
31951	Tridigm, Inc.	Pittsburg	PA
32293	Intersil	Cupertino	CA
32559	Dixer, Inc.	Santa Ana	CA
32997	Bourns Inc. (Trimpot Div)	Riverside	CA
33005	Jewell Electrical Inst. Inc.	Manchester	NH
33335	Logic Dynamics, Inc.	Gardena	CA
33716	Klingebacher Murray Co.	Los Angeles	CA
33855	Bourns, Inc.	Los Angeles	CA
33901	Calbar Corp.	Irvington	CA
34230	Mills Resistor Co.	Los Alamitos	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
35007	Aerovox Canada Ltd.	Amherst NS	Canada
37964	Linear Technology, Inc.	Burlington, Ont	CAN
44655	Ohmite Manufacturing Co.	Skokie	IL
45722	Porter-Cable	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
46157	Midwest Components, Inc.	Hustegon	MI
50522	Nonsante, Electronic Special Products	Cupertino	CA
50550	Electronic Concepts, Inc.	Eatontown	NJ
50811	Nonsor Corp.	Santee	CA
51167	Arlee Electronics, Inc.	Frenchtown	NJ
51506	Accurate Screw Machine Co.	Hatley	WI
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
52745	Timco	Los Angeles	CA
53476	Elnicon, Inc.	Buffalo	NY
53495	Data Components, Inc.	Gardena	CA
54361	Edwards Sheet Metal Works	Fredericktown	OH
54407	Power-One Co.	Camarillo	CA
55322	Sanket, Inc.	New Albany	NY
55566	RAF Electronic Hardware, Inc.	Seymour	CT
56289	Sprague Electric Company	North Adams	MA
56637	RCD Components, Inc.	Manchester	NH
57640	United Chem-Con Corp.	Philadelphia	PA
57956	Eel-Am, Inc.	Eldon	MO
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
59993	International Rectifier Semiconductor Div.	El Segundo	CA
60395	Elcec, Inc.	Alhidtas	CA
61394	Seeq Technology, Inc.	San Jose	CA
61441	Sarcnic	Palo Alto	CA
61529	Aromat Corp.	Mountainside	NJ
61735	Pelex Engineering, Inc.	College Park	MD
62483	Semitron Corp. of America	Torrance	CA
62643	United Chemicon, Inc.	Rosemont	IL
62786	Hitachi America Ltd.	San Jose	CA
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
63791	Star Micronics, Inc.	New York	NY
70310	Allentel Screw Prod. Co.	Garden City	NY
70903	Beldon Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Burgess Mfg. Div. McGraw-Edison, Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric, Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lamp[w]orks	Chicago	IL
71785	Cinch Manufacturing Company	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmwood (Electro Motive)	Millstonetic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72902	Erie Technological Prod. Inc.	Erie	PA
73138	Bechman Instruments, Inc.	Fullerton	CA
73612	Consolidated Electronic Wire and Cable Corp.	Chicago	IL
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74640	Illinois Condenser Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	Kulka Electric Corporation	Mt. Vernon	NY
75582	Leviton Mfg. Co.	Little Neck	NY
75915	Littelfuse, Inc.	Des Plaines	IL
76385	Almac Rubber Co., Inc.	Bloomfield	NJ
77062	Pabst Eng. Equipment Co.	Elizabeth	NJ
77132	United-Carr Inc., Potvin Div	Watertown	CT
77342	Potter and Brumfield Div. AMF	E. Princeton	IN
78189	Shakeproof Div. IL Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79136	Johns-Manville Products Corp	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corp.	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Inc.	Riverside	CA
80495	High Voltage Engineering Corp (Anderson Pwr Prod. Div)	Brighton	MA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81348	(Fed. Specs) Promulgated by General Services Administration Washington DC		
81349	Military Specification or Commercial Generic Number		
81541	Airpax Corp.	Cambridge	MD
81603	Race Products Co.	Chicago	IL
81851	Bentley-Harris Mfg Co.	Lionville	PA
82184	Standard Grigsby	Aurora	IL
82389	Switchcraft, Inc.	Chicago	IL
82877	Betron Mfg. Co., Inc.	Woodstock	NY
82893	Vector Electronics, Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool & Screw Corp.	Rockford	IL
85480	Brady W.H. Co.	Milwaukee	WI
86684	RCA	Harrison	NJ
86928	Semetron Mfg. Co., Inc.	Glendale	CA
87036	Accra-Cut Industries	Anaheim	CA
88245	Usuco Div., Litton Ind.	Van Nuys	CA
90201	Mallory Capacitor Co.	Indianapolis	IN
91506	Amgat, Inc.	Attleboro	MA
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91802	Industrial Devices, Inc.	Edgewater	NJ
91833	Keystone Electronics Corp.	New York	NY
91967	National Tl-Tronics	Hendrille	PA
92194	Alpha Wire Corp.	Elizabeth	NJ
93303	Pentagon Products Co.	Washington	DC
94222	Southco, Inc.	Lester	PA
94696	Rapoccraft Electric Co.	Chicago	IL
95146	Alco Electronic Prod., Inc.	Wm. Andover	MA
95303	RCA	Cincinnati	OH
95354	Methode Manufacturing Corp.	Rolling Meadows	IL
95566	Arnold Engineering Co.	Marengo	IL
95987	Wortenser Company, Inc.	Chicago	IL
96906	Military Std		
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Dubber Tech, Inc.	Gardena	CA
98291	Sealtecto Corp.	Mamaroneck	NY
98376	Zero Mfg. Co. (West)	Burbank	CA
98978	IEMC	Burbank	CA
99817	Protective Closures Co., Inc. (Caplugs Div)	Buffalo	NY
99217	Bull Industries, Inc.	Delavan	WI
99742	Perancoil	New Brunswick	NJ
99743	IMC	Raywood	CA
99800	Delevan Electronics Corp.	Aurora	NY

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS CORPORATION warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are fuses and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, including the model number and serial number. On receipt of this information, service information or a Return Material Authorization (RMA) number will be given. Add RMA number to shipping label. .Pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No. or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested when it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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